Assessment of Habitat for Sagebrush Steppe Dependent Birds at Craters of the Moon National Monument and Preserve

Final Report

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Executive Summary

It is estimated that shrubsteppe habitat has been reduced by greater than 1/3 in the Interior Columbia River Basin and that less than 1% of remaining shrubsteppe exists in its original condition (West 2000). Remaining shrubsteppe habitat exists in a patchwork of habitat islands which are often highly separated, and this fragmentation has serious implications for wildlife species (Sands et al. 2000, Knick and Rotenberry 2002). A significant number of shrubsteppe species are declining rangewide. A recent analysis and summary of issues within the shrubsteppe region examined BBS results for 25 upland birds that depend on or are found in shrubsteppe ecosystems, and reports that 10 of these species have exhibited long-term (1968-2001) population declines, and 13 species have shown short-term (1984-2001) declines (Dobkin and Sauder 2004). Of these 25 species, 11 were commonly detected at Craters during this study, and of those, eight currently have federal or state special conservation status.

This project was designed to supplement a basin-wide effort to assess distribution and habitat associations for at-risk bird species using standardized protocols at Craters of the Moon National Monument (Craters). The study began in 2002 and was conducted by Boise State University's Idaho Bird Observatory. This statewide effort surveyed shrubsteppe birds and habitat at some 50 sites across southwestern and south-central Idaho during 2002 and 2003. In 2004, an effort to survey shrubsteppe birds and habitat at Craters of the Moon National Monument and Preserve was undertaken, and followed similar design as the two previous years of study.

The study objectives were to:

1. Survey a representative sample of shrubsteppe habitats for shrubsteppe birds within Craters of the Moon National Monument and Preserve.
2. Obtain quantitative estimates of habitat attributes at the sample locations.
3. Identify habitats with the highest numbers of special-status shrubsteppe bird species.
4. Describe the habitats needed to provide viable populations of these species.
5. Assess the relative value of fragmented islands of shrubsteppe habitat (kipukas, vegetated lava) as habitat for shrubsteppe bird species.

We sampled a total of 21 sites for shrubsteppe birds and vegetation during the 2004 breeding season between 5 May and 23 June at Craters. We surveyed one site within the Craters of the Moon National Monument Wilderness Boundary, 19 sites within the Craters of the Moon Administrative Boundary, and two sites outside the Craters of the Moon Administrative Boundary. Including all detections, we counted a total of 3,338 birds of 37 different species at these 21 study sites. The most abundant breeding species detected during surveys were Horned Lark (*Eremophila alpestris*; $n = 932$), Western Meadowlark (*Sturnella neglecta*; $n = 781$), Brewer's Sparrow (*Spizella brewerii*; $n = 711$), Sage Thrasher (*Oreoscoptes montanus*; $n = 193$), Lark Sparrow (*Chondestes grammacus*; $n = 190$), Vesper Sparrow (*Pooecetes gramineus*; $n = 129$), Grasshopper Sparrow (*Ammodramus savannarum*; $n = 99$), Sage Sparrow (*Amphispiza belli*; $n = 74$), Mourning Dove (*Zenaida macroura*); ($n = 65$), Brown-headed Cowbird (*Molothrus ater*); ($n = 60$), Loggerhead Shrike (*Lanius ludovicianus*; $n = 42$), and Lark Bunting (*Calamospiza melanocorys*; $n = 31$).

The proportion of Craters sites where we detected Brown-headed Cowbirds, Sage Sparrows, Sage Thrashers, and Western Meadowlarks was roughly similar to other areas sampled in southern Idaho. However, we detected proportionately more Brewer's Sparrows, Grasshopper Sparrows, Horned Larks, Lark Buntings, Lark Sparrows, Loggerhead Shrikes, Sage Thrashers, and Vesper Sparrows, and fewer Gray Flycatchers at Craters sites. Craters was similar to other subregions where we sampled with regard to grass cover, but had lower shrub cover, higher forb cover, forb height, and shrub height, and significantly greater grass height than sites sampled within other areas. We suggest that these differences in vegetation attributes, in part, influenced the presence and abundance of shrubsteppe birds at our sample locations.

Brewer's Sparrows, Sage Sparrows, and Sage Thrashers are all closely tied to the distribution and extent of sagebrush, indicating that sagebrush habitat at Craters is comparable to other areas sampled in southern Idaho. In addition, we detected comparatively more Loggerhead Shrikes at Craters than within other subregions, possibly pointing to the importance of shrub heights, and especially shrub height diversity, to this species. Sites sampled at Craters also contained significantly greater grass and forb components than other sites sampled throughout southern Idaho, which likely contributed to the high proportion of the more grassland or generalist songbird species detected during this study. We detected Horned Larks and Western Meadowlarks at every Craters site during this study. Grasshopper Sparrows, Lark Sparrows, and Lark Buntings were also more common at Craters sites than other sites sampled in southern Idaho.

Three recent petitions to list the Greater Sage-Grouse as endangered resulted in a determination by the U.S. Fish and Wildlife Service that listing is unwarranted (U.S. Fish and Wildlife Service 2005). It is unknown to what extent management actions implemented for Greater Sage-Grouse will affect other shrubsteppe obligate passerines. It is assumed that management actions which result in improvements to Greater Sage-Grouse habitat will also benefit other shrubsteppe obligate birds. Greater Sage-Grouse have been considered a good "umbrella" species for management of other shrubsteppe-dependent birds and mammals, and it has been assumed that successful management for this species will benefit other shrubsteppe obligates. We examined Greater Sage-Grouse management guidelines in relation to other bird species commonly found in Idaho's shrubsteppe regions and conclude that Sage-Grouse may be an adequate "umbrella" species for Brewer's Sparrows and Sage Thrashers, however, Sage Sparrows, Gray Flycatchers, and Loggerhead Shrikes (all important shrubsteppe species) would be less likely to occur under the set of habitat conditions which favor Sage-Grouse.

Because they generally had lower shrub cover and height values, greater forb cover, lower grass cover, lower litter values, and significantly greater coverage of bare ground, we would not expect *Vegetated Lava* habitats to be overly important to shrubsteppe-obligate birds, but would expect this habitat type to be associated more with the grassland or generalist species such as Horned Lark, Western Meadowlark, and Lark Sparrow. While kipukas may be valuable to offer insight into historic pre-disturbance vegetation communities, these habitats are highly isolated and fragmented. Over the long-term, restoration and conservation of large contiguous blocks of native shrubsteppe vegetation at Craters would benefit the greatest number of shrubsteppe-obligate songbirds.

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Acknowledgements

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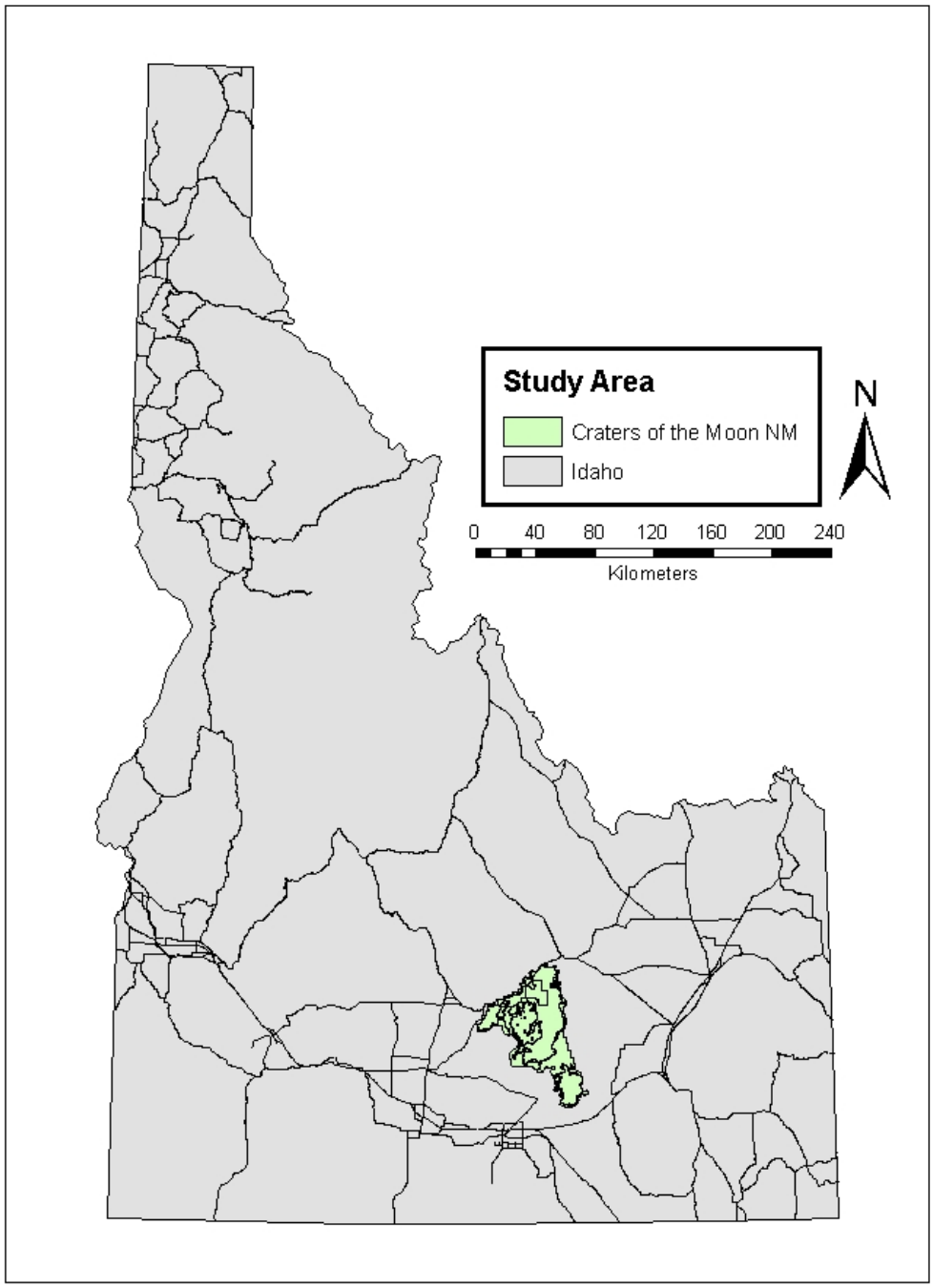
Introduction

Craters of the Moon National Monument, located in south central Idaho, was originally established on 2 May 1924 by President Calvin Coolidge (Presidential Proclamation #1694) to protect geologic features of portions of the Great Rift volcanic zone. The Monument's original 53,440 acres were expanded by 661,000 acres on 9 November 2000 to encompass the entire Great Rift Volcanic Rift Zone and surrounding shrubsteppe habitat (Fig. 1; Presidential Proclamation #7373). The National Park Service now administers roughly two thirds of the new lands as Craters of the Moon National Preserve, a unit of the National Park System. The remainder of the expansion is managed in cooperation with the Bureau of Land Management (BLM), Shoshone District. The Idaho GAP project estimates that over 60,000 acres of shrubsteppe vegetation occurs within the NPS portion of the Monument. Most of the shrubsteppe areas within the newly expanded NPS portion of the Monument have never been systematically surveyed. This project was designed to supplement a basin-wide effort to assess distribution and habitat associations for at-risk bird species using standardized protocols at Craters of the Moon National Monument (Craters).

Sagebrush-dominated (*Artemisia* spp.) shrubsteppe occurs as a result of the shared dominance between shrubs and herbaceous plants (West 2000). This condition exists in semiarid climates with high levels of variation in annual rainfall, is highly unstable, and is easily affected by disturbances, both human-caused and natural (West 2000). Past uncontrolled livestock grazing and the introduction of exotic annual grasses and forbs have had a severe impact on this community. Annual grasses, namely cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum caput-medusae*), pose the greatest threat (Pyke 2000, USDI BLM 2002). The understories of an estimated 50 – 60% of native shrubsteppe are dominated by these annuals, and this has altered fire regimes to larger, hotter, more frequent fires that occur earlier in the year than historically (West 2000). Recent extensive wildfires have converted millions of acres of native shrubsteppe to annual grasslands, especially in eastern Oregon, southern Idaho, and northern Nevada and Utah (Pellant and Hall 1994), and recovery of these areas to historic conditions is unlikely (West and Young 2000). It is estimated that shrubsteppe habitat has been reduced by greater than 1/3 in the Interior Columbia River Basin and that less than 1% of remaining shrubsteppe exists in its original condition (West 2000). Remaining shrubsteppe habitat exists in a patchwork of habitat islands which are often highly separated, and this fragmentation has serious implications for wildlife species (Sands et al. 2000, Knick and Rotenberry 2002). A recent assessment of the Columbia River Basin has identified shrubsteppe as the highest priority for conservation based on trends in habitat and wildlife populations (Saab and Rich 1997).

Sagebrush steppe supports approximately 250 species of terrestrial vertebrates, the majority being birds and mammals (Braun et al. 1976). A significant number of these shrubsteppe species are declining rangewide, and have been identified as species of concern by federal and state wildlife agencies (Saab and Rich 1997, Paige and Ritter 1999, Knick et al. 2003). Declines of shrubsteppe vertebrate species are closely associated with habitat loss or degradation (Paige and Ritter 1999). The US Fish and Wildlife Service and the Biological Resource Division (Region 1) of the U.S. Geological Survey lists several birds including Greater Sage-Grouse (*Centrocercus urophasianus*), Loggerhead Shrike *(Lanius ludovicianus)*, Brewer's Sparrow (*Spizella breweri),* and Sage Sparrow (*Amphispiza belli*) as Species at Risk due to their dependence on this

Figure 1. Location of Craters of the Moon National Monument study area in southcentral Idaho.



ecosystem. Greater Sage-Grouse, Swainson's Hawk (*Buteo swainsoni*), Short-eared Owl (*Asio flammeus*), and Brewer's Sparrow have been included on the national Partners in Flight Watch List (Rich et al. 2003), and the Idaho Chapter of Partners in Flight has identified shrubsteppe birds as an avian community that warrants special concern and conservation efforts. Specific habitat requirements for many shrubsteppe bird species have not been studied in Idaho, and for some species, anywhere within the shrubsteppe region. As a result, managers lack quantitative, well-supported descriptions of habitats needed to maintain viable populations of these species. The Chapter recommended surveys to identify high-quality habitats for these species, especially the shrubsteppe obligates, and to provide a foundation for developing a long-term monitoring program to supplement the Breeding Bird Survey.

Greater Sage-Grouse are generally declining rangewide due to loss and alteration of habitat (Braun 1998, Schroeder et al. 1999, Connelly et al. 2000). However, three recent petitions to list the Greater Sage-Grouse as endangered resulted in a determination by the U.S. Fish and Wildlife Service that listing is unwarranted (U.S. Fish and Wildlife Service 2005). A national strategy has been developed to help guide and coordinate management of the species throughout its range (U.S. Department of the Interior 2004). Habitat losses have been severe in Idaho, and conservation efforts are ongoing to protect and maintain suitable habitat, improve degraded habitat, and restore habitats where possible (U.S. Department of the Interior 2000). It is unknown to what extent management actions implemented for Greater Sage-Grouse will affect other shrubsteppe obligate passerines. It is assumed that management actions which result in improvements to Greater Sage-Grouse habitat will also benefit other shrubsteppe obligate birds.

The newly expanded Craters of the Moon National Monument also contains a unique habitat feature called "kipukas". Kipukas are islands of older terrain and vegetation that became isolated as lava diverged and flowed around areas of higher ground during the most recent eruptive episodes. There are over 500 kipukas, ranging from 0.1 to over 1,000 acres in size and totaling over 11,000 acres. In addition to kipukas, many older flows within the Craters of the Moon Lava Field have well-established shrubsteppe communities. The expansion Proclamation recognized the importance of the area's isolated vegetative communities and their importance as wildlife habitat. Unlike the vast tracts of uninterrupted shrubsteppe surrounding the lava fields, the habitat within lava fields is fragmented into small isolated parcels. While most have been subject to minimal disturbance from livestock grazing, the relative value of these islands of shrubsteppe habitat for species of associated birds is unknown. Such information is important in decisions regarding appropriate responses to wildland fires (e.g. suppression).

In 2000 the BLM's Idaho State Office funded a pilot effort to assess the feasibility of a study designed to describe habitat characteristics that provide for viable populations of special-status sagebrush obligate bird species. This study continued during 2002 and 2003 and was conducted by Boise State University's Idaho Bird Observatory, and included other partners such as Idaho Department of Fish and Game Nongame Wildlife Program, Point Reyes Bird Observatory, USGS-BRD Snake River Field Station, and private partners such as the M.J. Murdock Charitable Trust. This statewide effort surveyed shrubsteppe birds and habitat at some 50 sites across southwestern and south-central Idaho during 2002 and 2003. It was determined that an effort to survey shrubsteppe birds and habitat at Craters of the Moon National Monument and Preserve should follow a similar design and use data collection procedures compatible with this statewide effort; therefore, data collected from the two studies could be directly compared and merged for statewide analyses.

The objectives of this study during the 2004 field season conducted at Craters were to:

6. Survey a representative sample of shrubsteppe habitats for shrubsteppe birds within Craters of the Moon National Monument and Preserve.
7. Obtain quantitative estimates of habitat attributes at the sample locations.
8. Identify habitats with the highest numbers of special-status shrubsteppe bird species (which will be used as an indication of viability).
9. Describe the habitats needed to provide viable populations of these species.
10. Assess the relative value (in comparison to larger blocks of habitat) of fragmented islands of shrubsteppe habitat (kipukas, vegetated lava) within Caters of the Moon National Monument and Preserve as habitat for shrubsteppe bird species.

Methods

Site Selection

We worked with the GIS lab at the Lower Snake River District, BLM, during March and April 2004 to randomly select potential study sites. We used GIS to select study sites based on limited criteria. First, potential study sites were located in both contiguous shrubsteppe habitat and within kipukas in the following habitat/vegetation types based on GIS habitat coverage layers provided to us by NPS:

- Mid- to high-elevation sagebrush steppe
- Low-elevation sagebrush steppe
- Annual grassland
- Perennial grassland
- Vegetated lava

We further specified that sites be within 2 km of a road or trail (to allow access), and at least 5 km apart to allow sufficient area to establish sampling plots and to minimize dependency among sites. This random selection resulted in the identification of 50 potential study sites at Craters. The NPS Project Manager assisted us throughout this process and approved the final selection.

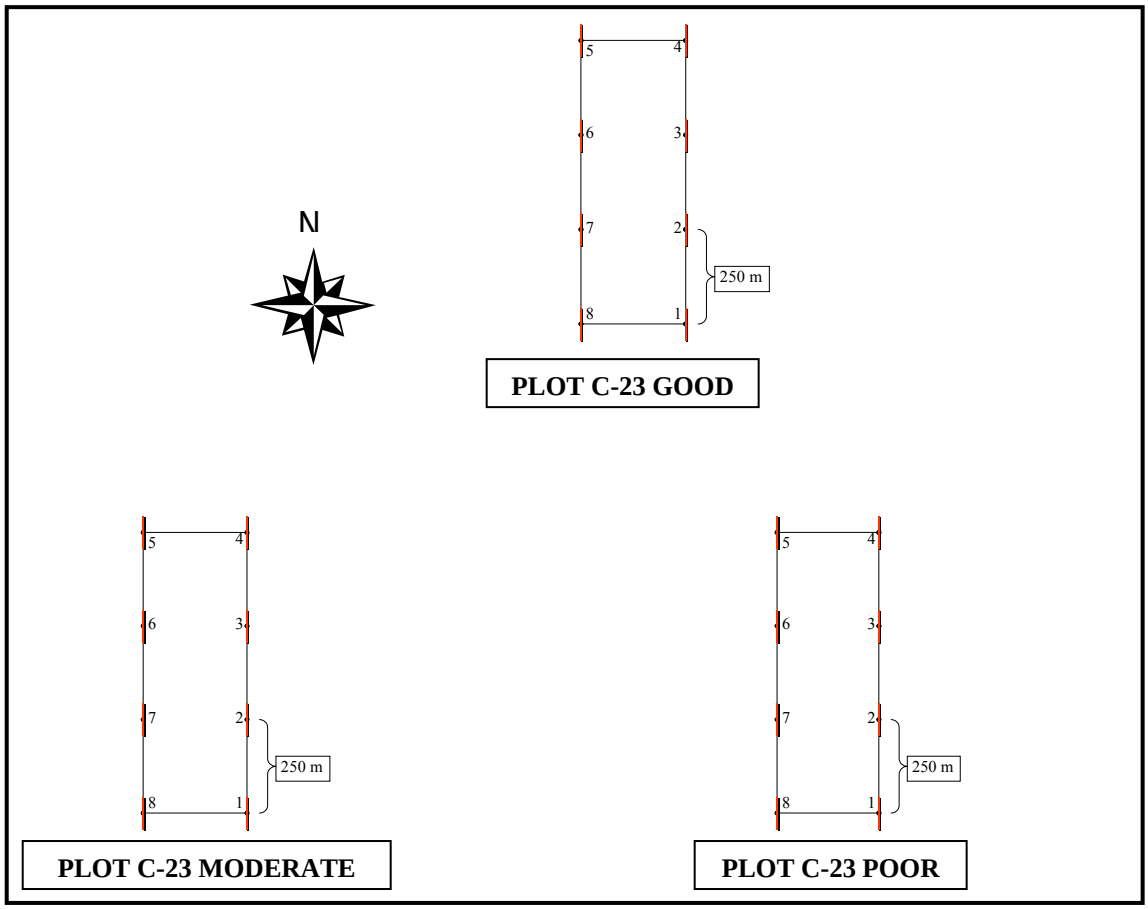
We randomized the order in which study sites were visited. As sites were visited, we first assessed the appropriateness of each for inclusion in this study by reviewing site selection criteria listed above. We then assessed habitat within the indicated area, and a site was considered appropriate if a clear gradient of habitat quality existed where three sampling plots could be established: one each in relatively good, moderate, and poor habitats. It was also important that all sampling plots at each site were laid out within the same "ecological site", i.e., all plots were placed at approximately the same elevation, slope, aspect, soil type, etc. It was assumed that all sampling plots within a site had the same potential for both vegetation and birds, but that past disturbances including fire, grazing, recreation, or other causes had created the variation in habitat quality. Approximately 100 ha. of contiguous habitat in similar condition were required for establishment of each sampling plot. Many of the randomly selected study sites were not located in large enough habitat areas to allow for establishment of sampling plots

consistent with this statewide effort and were therefore dropped from consideration.

Site Layout

Each study site consisted of 3 plots, one each established within relatively good, moderate, and poor quality habitats as described above. Most plots contained 8 bird/vegetation sampling points, typically in a grid consisting of 2 rows of 4 points, however, a small number of plots were shaped to fit the habitat (Fig. 2). Plots were typically oriented north/south. In all cases, sampling points were located at least 250 m apart, and plots were located at least 250 m from each other. We tried to locate all sampling points within a plot at least 250 m from habitat edges. We established the first sampling point at each plot by randomly selecting a distance and direction from a predetermined starting point. Sites were plotted as accurately as possible on BLM 1:100,000 base maps and USGS 7.5 minute topographic maps. All sampling points were located using the Global Positioning System (GPS; Lat/Long, datum NAD 27), and coordinates were recorded on field data sheets. All location data were later transformed to datum NAD 83. We took a photo of the habitat from the first sampling point at each plot facing north, using a digital camera. Each sampling point was marked with rebar and surveyor's flagging.

Figure 2. Typical site layout (example site: Craters-23) showing placement of three plots, each containing eight sampling points.



Bird Counts

We followed bird survey protocol modified from Point Reyes Bird Observatory's Shrubsteppe Bird Project (PRBO 2001). We visited sites only once during the season. Bird counts were conducted between 5 May and 23 June 2004. We conducted 5-minute point counts at each sampling point, beginning counts approximately 20 minutes after sunrise to avoid the dawn chorus, and ending counts no later than 10 AM or approximately 3 - 4 hours after sunrise. Points were approached quietly to cause minimal disturbance to birds. We began counts approximately 2 - 3 minutes after reaching each sampling point, allowing time for birds to settle down after our arrival. We recorded the starting time, the time after three minutes, and the ending time on data sheets for each count. Each bird detected during point counts was recorded only once on data sheets. We recorded birds detected using standard American Ornithologist's Union (AOU) species codes (Appendix A). If birds flushed from the count area upon our arrival at the sampling point, they were included in the count. We estimated distances to birds detected during point counts, and they were recorded in 25 m increments (<25 m, 25-50 m, 50-75 m, 75-100 m, and >100 m but <200 m; Appendix B-Field Data Forms). We recorded flyovers and flocks of birds separately. Unless a flock or family group was detected, we recorded only one bird per line on field data sheets. We did not conduct counts during heavy rains or when winds exceeded 20 km/h (Beaufort Scale >Force 3; Appendix C), but we found that birds continued to sing prolifically during intermittent rains when winds were calm.

Vegetation Assessment

We conducted assessments of vegetation at each survey point using methods developed by the Bureau of Land Management for evaluating Greater Sage-Grouse habitat. We used the Line Point Intercept Method (U.S. Department of the Interior 2000, pages 34-39), selecting this technique because of its wide use by BLM resource area biologists for assessing rangeland habitat in southern Idaho. Because this method is used frequently by BLM personnel in Idaho for assessing rangeland quality and suitability for Greater Sage-Grouse, results from our study will be easily interpreted and directly comparable to results from ongoing rangeland assessments.

At each bird sampling point, a 100 m vegetation transect was established in a north/south orientation. The bird sampling point was centered along the transect at 50 m. Along each 100 m transect, we recorded vegetation every 2 m, for a total of 50 vegetation sampling intercepts per 100 m transect. Starting at 0 m, we dropped a 48 inch calibrated measuring rod vertically at arm's length just out from the tip of our boot. We recorded the species of each plant touching the measuring rod at up to three different layers, recording all shrubs, grasses, and forbs touching the measuring rod, using standard vegetation codes (Appendix D). We recorded the maximum height of each plant touching the measuring rod. For grasses touching the measuring rod, we recorded their maximum height, including the height of seed heads. The only exception was Sandberg's bluegrass (*Poa secunda*; POSE). Because of its uniformly short heights and unique growth form, height measurements do not include the flowering heads with this perennial grass species. Where possible, we recorded subspecies of sagebrush, i.e., Wyoming big sagebrush (*A. t. wyomingensis*), mountain big sagebrush (*A. t. vaseyana*), basin big sagebrush (*A. t. tridentata*), low sage (*A. t. arbuscula*), etc. We also recorded substrate at each vegetation sampling point, including bare ground, rock, litter, or biological soil crust. We then paced 2 m to the next vegetation sampling point, repeating the process described above, until reaching the end of the 100 m vegetation transect. We conducted vegetation sampling as described above at each of the

bird sampling points contained within each plot. After completion of vegetation sampling at each plot we made an ocular assessment of habitat at the plot as to its suitability for Greater Sage-Grouse based on the presence of forbs using the *Site Preferred Forb Abundance and Diversity Form for Sage-Grouse Evaluations* (U.S. Department of the Interior 2000; Appendix B).

Analyses

We surveyed a representative sample of shrubsteppe habitats for shrubsteppe birds within Craters of the Moon National Monument and Preserve and obtained quantitative estimates of bird abundance and habitat attributes at sample locations. This project was designed to assess distribution and habitat associations for shrubsteppe birds using standardized protocols, and to identify the habitats with the highest numbers of special-status species. Another important objective of this study was to assess the relative value of fragmented islands of shrubsteppe habitat to shrubsteppe birds including kipukas and vegetated lava.

Craters Bird/Habitat Relationships

We present results from this study in several different ways. First, we summarized bird counts by site, including all detections and flyovers, to give NPS managers a sense of the entire bird community, both shrubsteppe birds and other species, present within the study area. Next, for the 10 most commonly detected species, we summarized count data by point, calculating the number of each species detected within 100 m, excluding flyovers. Because they are not considered shrubsteppe obligates, we excluded Brown-headed Cowbird (*Molothrus ater*) and Mourning Dove (*Zenaida macroura*) from results presented in this report. Gray Flycatcher (*Empidonax wrightii*) is also excluded from analyses because of small sample size, however we do discuss range and habitat requirements of this species. We included Lark Bunting (*Calamospiza melanocorys*), although this species is not a shrubsteppe obligate, because of its relative rarity in the state and presence at Craters. We then summarized count data by plot and present them both in tabular form and graphically, showing the study sites and plots where each species was present and their relative abundances.

We summarized vegetation variables both at the point and plot level. For each of the 10 most commonly detected bird species, we summarized vegetation parameters at the plots where each species was present. Next, we modeled the probability of presence for each of these 10 species using logistic regression models (Johnson 1998, Hosmer and Lemeshow 2000). The goal of these analyses was to determine which vegetation variables were associated with changes in the probability of occurrence of each bird species. Logistic regression is an ideal tool for modeling habitat associations on small study areas because it does not require that the predictor variables be normally distributed. Furthermore, the dependent variable is binary, with presence/absence as the outcome. We used backwards stepwise selection and included predictor variables with $P \leq 0.1500$ (SYSTAT 2000).

Overall, 22 vegetation/habitat variables were initially considered for this analysis. To avoid over specification of the logistic regression models, it was necessary to reduce the number of predictor variables used. To do this, we evaluated the Pearson correlation between all pairs of variables to remove those that were highly correlated. Seven pairs had correlation coefficients greater than 0.70 in absolute magnitude. The standard deviation of sagebrush heights also was

included as a predictor variable. This variable is an indication of the vertical structure of shrubs within a stand, and proved to be an important variable for many bird species.

We included the following predictor (or explanatory) variables in logistic regression models:

- Percent cover of sagebrush
- Mean sagebrush height
- Sagebrush height standard deviation
- Percent cover of other shrubs
- Mean other shrub height
- Percent cover of forbs
- Mean forb height
- Percent cover of grasses
- Mean grass height
- Percent cover of litter
- Percent cover of BARE (bare ground, rocks, and biological soil crusts)

Statewide Bird/Habitat Relationships

We also present results from analyses of bird/habitat relationships from all sites sampled within southwestern and south central Idaho during 2002-2004 to compare with Craters results. The goal of these analyses was to determine which vegetation variables were associated with changes in the probability of occurrence of bird species within the study area. Because the goal was to compare the variables across species, common models were fit to all species.

For statewide assessment of bird/habitat relationships, we modeled the probability of presence using a logistic regression model with presence or absence as the outcome (Hosmer and Lemeshow 2000). The model was run separately for each of the 10 species presented in this report. Because habitats within the study area were selected to represent a gradient of habitat quality at the site, observations within a site were likely correlated with one another. Thus all models were modified with generalized estimating equations methodology (Hardin and Hilbe 2002). This methodology builds correlations among the observations into estimations of variance, based on an a priori decision of how the observations within a site are correlated, but the model is robust to misspecification of this structure. It was felt that all observations within a site were likely correlated in the same way with one another.

Overall, 22 vegetation/habitat variables were initially considered. In order to limit the number of variables included in any one model, Pearson correlations between all pairs of variables were evaluated to remove highly correlated variables. Seven pairs had correlation coefficients greater than 0.70 in absolute magnitude. These generally involved expected combinations: percent shrub cover was highly correlated with percent sagebrush cover (R=0.86), for example. In four of these cases, the general variable was selected (for example, percent forb cover over percent perennial forb cover) for use in the model. In two of these cases, sagebrush variables (percent cover and mean height) were selected over the more general shrub categories. Multi-collinearity was also addressed by looking at condition indices (Draper and Smith 1998). From this evaluation, two additional variables were deleted based on their association with percent bare ground (percent grass and percent forb).

In total, 12 variables were retained for use in analyses:

- Mean Elevation
- Percent cover of sagebrush
- Mean sagebrush height
- Sagebrush standard deviation
- Mean Forb Height
- Percent Annual Forbs
- Mean Annual Forb Height
- Mean Grass Height
- Percent Annual Grass
- Mean Annual Grass Height
- Percent BARE
- Percent cover of Litter

Analysis of Regional Vegetation Attributes

In order to compare overall vegetation attributes at Craters sites to other sites sampled in southwestern and south central Idaho during 2002-2004, we conducted an analysis to determine if, and how, vegetation differed among the 15 subregions sampled (Table 1). Because vegetation at sample locations was characterized by 22 variables, a univariate analysis of each variable would result in highly inflated p-values, making it difficult to determine meaningful differences among subregions. Therefore, we used a principle components analysis to reduce the 22 variables to a manageable number of six independent variables. The number of components was selected by the minimum eigenvalue criterion and review of a scree plot. Varimax rotation was used to enhance interpretability.

Table 1. Subregions sampled for shrubstepp birds and habitat during 2002-2004; Idaho Bird Observatory.

Subregion
Copper Basin
Lemhi Valley
Pahsimeroi Valley
Sawtooth Valley
Glenn's Ferry
Murphy
Riddle
Sheep Creek
Triangle
Burley
Cassia
Jarbidge
Shoshone
Craters
Hixon

Once the components were selected and interpreted, a factor score was calculated for each of the 219 site/habitat combinations used in the analysis. To determine if any of the vegetation

characteristics differed among subregions, a univariate analysis of variance was run on each of the six factor scores. The analysis was modified by including a separate term for the variance of each region. This step was necessary to accommodate the heterogeneity of variances among the sites, and allowed estimation of the factor score means for each subregion. Pairwise inspection of regional differences followed, after overall significance had been established. Analyses of regional vegetation attributes were conducted in SAS version 9 (2003; procedures FACTOR and MIXED).

Last, we summarized habitat at plots as to their suitability for Greater Sage-Grouse based on the presence of forbs using the *Site Preferred Forb Abundance and Diversity Form for Sage-Grouse Evaluations* (U.S. Department of the Interior 2000; Appendix B).

Results

We sampled a total of 21 sites for shrubsteppe birds and vegetation during the 2004 breeding season between 5 May and 23 June at Craters (Fig. 3). We surveyed one site within the Craters of the Moon National Monument Wilderness Boundary (Site C19), 19 sites within the Craters of the Moon Administrative Boundary, and two sites outside the Craters of the Moon Administrative Boundary (Sites A2 and L48; Fig. 3). Including all detections, we counted a total of 3,338 birds of 37 different species at these 21 study sites (Table 2). The most abundant breeding species detected during surveys were Horned Lark (*Eremophila alpestris*; *n* = 932), Western Meadowlark (*Sturnella neglecta*; *n* = 781), Brewer's Sparrow (*n* = 711), Sage Thrasher (*Oreoscoptes montanus*; *n* = 193), Lark Sparrow (*Chondestes grammacus*; *n* = 190), Vesper Sparrow (*Pooecetes gramineus*; *n* = 129), Grasshopper Sparrow (*Ammodramus savannarum*; *n* = 99), Sage Sparrow (*n* = 74), Mourning Dove; (*n* = 65), Brown-headed Cowbird; (*n* = 60), Loggerhead Shrike (*n* = 42), and Lark Bunting (*Calamospiza melanocorys*; *n* = 31; Table 1).

Figure 3. Location of shrubsteppe bird study sites at Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

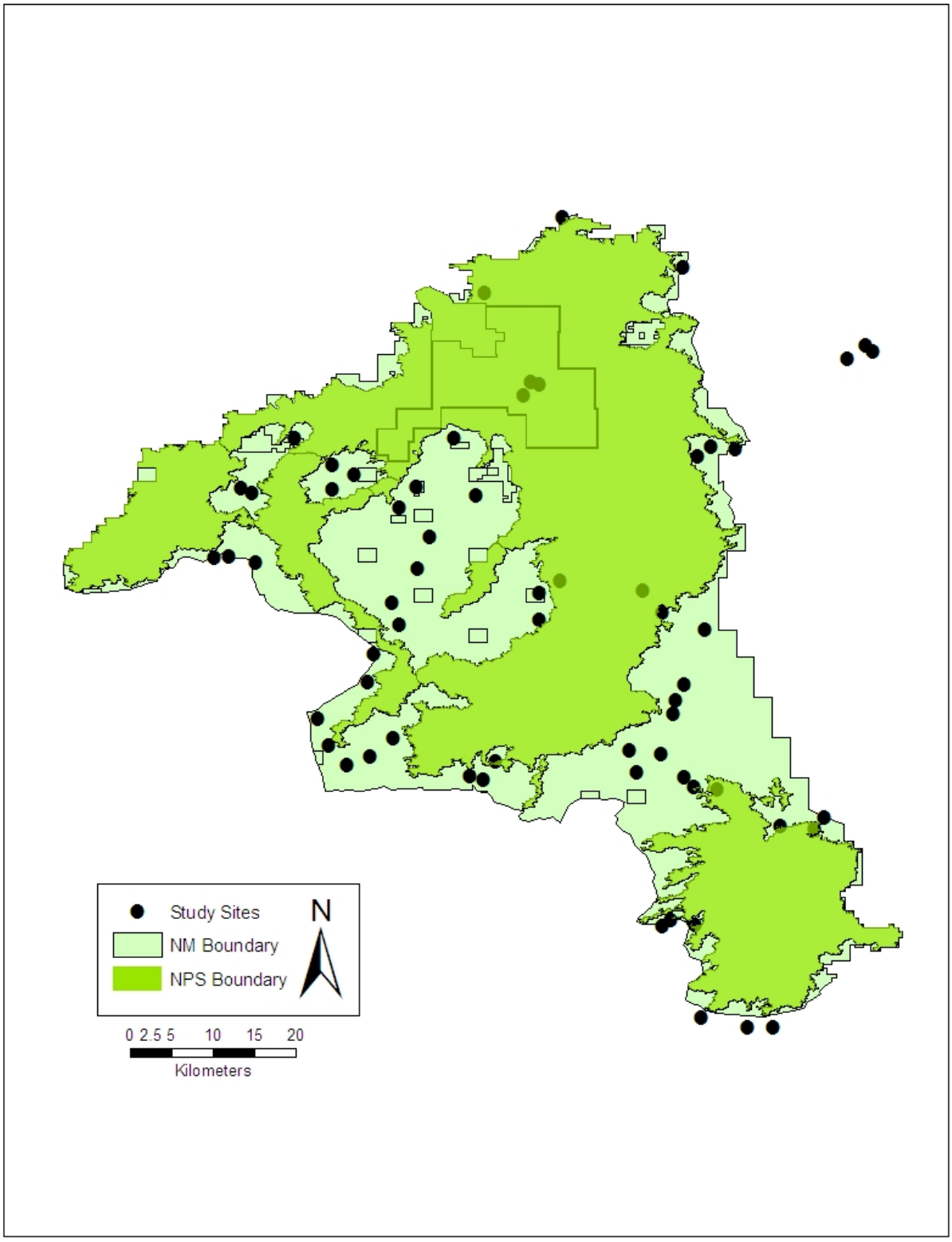


Table 2. Number and species of birds detected by site during standardized point counts at Craters of the Moon National Monument and Preserve, Spring 2004; Idaho Bird Observatory. Table includes all species detected and flyovers.

Species	A2	C11	C15	C16	C19	C20	C23	C25	C29	C30	C34	C35	C38	C39	C7	L31	L33	L41	L42	L46	L48	Total
Bank Swallow				1																	1	2
Blue-gray Gnatcatcher													1									1
Brown-headed Cowbird		4	4			3	5	1	9	6	3	1	1	2		2	7	2	6	2	2	60
Brewer's Blackbird							1				2									4		7
Brewer's Sparrow	53	42	57	58	27	59	35	33	21	20	25	7	49	54	33	21	49	14	18	10	26	711
Black-throated Sparrow	1																					1
Canada Goose																				11		11
Chipping Sparrow							1															1
Clark's Nutcracker					1																	1
Cliff Swallow		1					1															2
Common Nighthawk	1		1		2	1				3	1	1				4						14
Common Raven		1	1		3	1	2	1	3	1	1	1				3	1		9		1	29
Eastern Kingbird	1																					1
Ferruginous Hawk											1			1								2
Gray Flycatcher	3	1													1							5
Grasshopper Sparrow			7		1					5	9	1	7		7	6	10	23	7	16		99
Greater Sage-Grouse												1										1
Horned Lark	5	31	42	41	13	43	21	24	38	70	100	83	60	36	35	69	68	58	45	34	16	932
Killdeer							1															1
Lark Bunting								1		8	9						4	1	8			31
Lark Sparrow	1	14	13				6	16	13	4	10	12	1		13	2	13	9	23	19	21	190

Table 2. Continued.

Species	A2	C11	C15	C16	C19	C20	C23	C25	C29	C30	C34	C35	C38	C39	C7	L31	L33	L41	L42	L46	L48	Total
Long-billed Curlew																4	1		11			16
Loggerhead Shrike		2	5		2	3	5	6	1	1	6	1	1		1	3	2		2		1	42
Mourning Dove	5	4	3		5		2	2	1	13			2		2	10	3	6	3	4		65
Northern Flicker					1																	1
Northern Harrier	1			2			1		1													5
Prairie Falcon														2								2
Rock Wren	2	6			6			5		2	1					2	1	2				27
Red-winged Blackbird															1							1
Say's Phoebe																	1					1
Sage Sparrow	12	4	1	1		1		9	5	3		1		28	2	4	2		1			74
Sage Thrasher	16	1	12	10	12	21	5	7	3	18	8		17	13	10	6	11	7	6	2	8	193
Tree Swallow							1														1	2
Unid. Flycatcher												1										1
Unid. Gull											1									1		2
Unid. Hummingbird						1					1				1					1		4
Unid. Bird				1	1			1				1										4
Vesper Sparrow	13	2	10	42	7	2							15	18	2				8	6	4	129
Violet-green Swallow					2																	2
Western Kingbird																			1		1	2
Western Meadowlark	4	18	37	12	13	40	57	53	53	31	45	36	37	3	33	74	64	38	59	47	27	781
Total	118	131	193	168	96	175	144	159	148	185	223	147	191	157	141	210	237	160	207	157	109	3338

Craters Results Compared to Statewide Surveys

For the 12 most common bird species associated with shrubsteppe in southern Idaho, species composition and relative abundance at Craters of the Moon National Monument and Preserve, with a few exceptions, were comparable to other sites sampled throughout southwestern and south central Idaho during 2002-2004 (Table 3). The proportion of Craters sites where we detected Brown-headed Cowbirds, Sage Sparrows, Sage Thrashers, and Western Meadowlarks was roughly similar to other areas sampled in southern Idaho. However, we detected proportionately more Brewer's Sparrows, Grasshopper Sparrows, Horned Larks, Lark Buntings, Lark Sparrows, Loggerhead Shrikes, Sage Thrashers, and Vesper Sparrows, and fewer Gray Flycatchers at Craters sites (Table 3).

Table 3. Numbers of birds detected within 100 m (flyovers excluded), and the proportion of sites in which each species was detected at Craters of the Moon National Monument and Preserve compared to other sites in southwestern and south central Idaho sampled during 2002-2004.

	Craters of the Moon		Statewide	
Species	# Counted	Proportion of Sites where Species Detected ($n = 21$)	# Counted	Proportion of Sites where Species Detected ($n = 73$)
Brown-headed Cowbird	19	38.10%	57	33.78%
Brewer's Sparrow	592	100.00%	2355	93.24%
Gray Flycatcher	5	14.29%	107	29.73%
Grasshopper Sparrow	93	57.14%	118	25.68%
Horned Lark	567	100.00%	1354	87.84%
Lark Bunting	22	28.57%	30	12.16%
Lark Sparrow	148	71.43%	309	55.41%
Loggerhead Shrike	27	61.90%	54	39.19%
Sage Sparrow	53	57.14%	298	58.11%
Sage Thrasher	129	85.71%	550	78.38%
Vesper Sparrow	96	57.14%	827	74.32%
Western Meadowlark	456	100.00%	1349	85.14%

Craters Bird/Habitat Results by Species

Modeling presence/absence using logistic regression resulted in significant overall models for all 10 of the following species, identifying key habitat components contributing to the presence of each species at Craters. Results from these analyses are best interpreted using the odds ratios generated for each explanatory variable. The odds ratio identifies the ratio between the odds of the species being present for a given unit of the explanatory variable, and the odds of the species being present for a one-unit change in that explanatory variable. The odds ratio is calculated by taking the exponent of the logistic regression estimate for each explanatory variable.

Horned Lark

Throughout the species' range, Horned Larks are found in grasslands, shrubsteppe, deserts, and

higher elevation alpine areas of western North America, as well as in landscapes altered by human activity such as agricultural lands and pastures (Beason 1995, Dinkins et al. 2001). Typically, Horned Larks are associated with areas containing few shrubs, shorter herbaceous vegetation, and more bare ground. A recent trend analysis of Breeding Bird Survey (BBS) data revealed that Horned Larks have experienced both short-term (1984-2001) and long-term (1968-2001) population declines (Dobkin and Sauder 2004). Furthermore, within the Western BBS region, routes within the Columbia Plateau also experienced significant short-term declines (Dobkin and Sauder 2004).

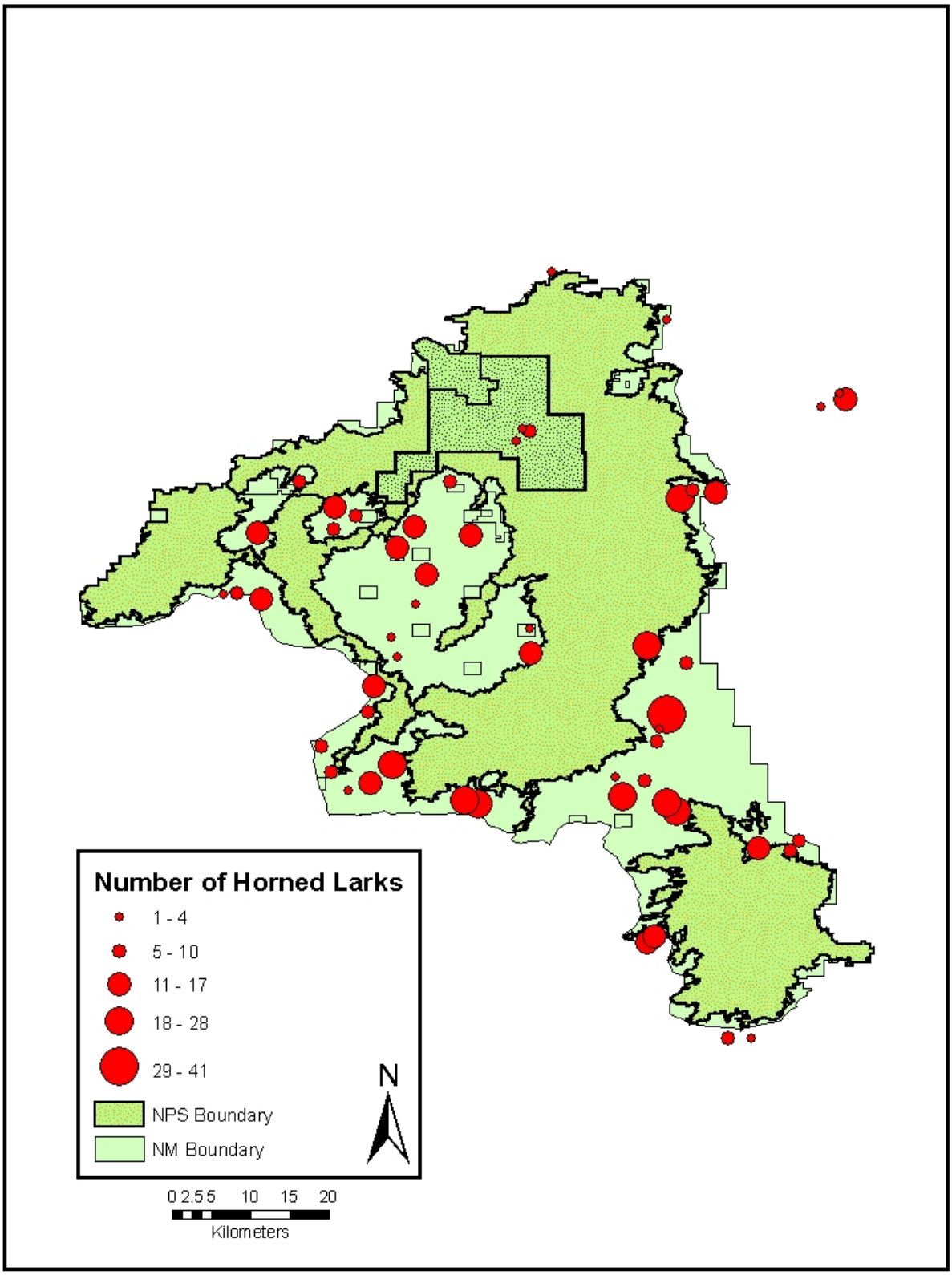
Horned Larks were the most common bird species detected at Craters during this study and were present at all 21 study sites and at 55 out of 63 sampling plots (n = 932; Table 1). Horned Larks were most abundant at sites C34 (n = 100), C35 (n = 83), C29 (n = 70), L31 (n = 69), and L33 (n = 68; Table 1; Fig. 4). In general, Horned Larks were most abundant at the more southerly study sites within the National Monument where habitat was more degraded by annual grasses and forbs (Fig. 4). Horned Larks were present at plots where sagebrush cover ranged from 0.0% to 13.5% (mean = 4.54%), where forb cover ranged from 0.83% to 11.5% (mean = 5.33%), and where grass cover ranged from 3.33% to 23.2% (mean = 13.4%; Table 4).

Table 4. Summary of vegetation variables at plots where Horned Larks were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Horned Lark: Number of Plots Present = 55

Vegetation Parameter	Mean	SD	Minimum	Maximum
Elevation (m)	1488.38	128.78	1272.25	1810.63
% Shrub Cover	6.28	3.99	0.08	14.00
Shrub Height (in.)	22.09	6.03	13.80	38.30
% Sagebrush Cover	4.54	3.68	0.00	13.50
Sagebrush Height (in.)	24.54	8.81	0.00	42.00
Sagebrush Height Diversity Index (SD)	10.06	3.89	0.00	24.74
% Forb Cover	5.33	2.35	0.83	11.50
Forb Height (in.)	5.22	2.04	2.10	11.60
% Annual Forb Cover	3.25	1.96	0.20	8.10
Annual Forb Height (in.)	4.18	1.93	1.10	9.00
% Perennial Forb Cover	2.08	1.33	0.30	6.50
Perennial Forb Height (in.)	6.33	2.63	1.67	13.70
% Grass Cover	13.40	4.39	3.33	23.20
Grass Height (in.)	7.41	2.94	2.10	14.20
% Annual Grass Cover	5.16	3.55	0.00	15.30
Annual Grass Height (in.)	5.24	2.17	0.00	10.40
% Perennial Grass Cover	8.24	3.16	2.60	15.60
Perennial Grass Height (in.)	8.35	3.20	2.20	16.80
% Litter	3.08	1.32	0.80	9.00
% BARE	11.62	2.90	6.00	22.20

Figure 4. Relative abundance and location of sampling plots where Horned Larks were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.



At Craters, Horned Larks were negatively associated with sagebrush cover, sagebrush height diversity, and the height of other shrubs (Table 5). The logistic regression estimate for percent sagebrush cover is (-0.0286); the odds ratio is 0.9718 (Table 5). To further interpret these results, for every one-percent increase in sagebrush cover, the odds that Horned Larks were present at a site decreased (because the estimate is negative) by 2.82% (or 1 – 0.9718). Similarly, as the diversity in sagebrush height increased by one standard deviation unit and the cover of other shrubs increased by one percent, the odds that Horned Larks were present decreased by 6.72% and 3.58%, respectively.

Table 5. Results from logistic regression analysis for Horned Lark, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Horned Lark Logistic Regression Results: Craters

Vegetation Parameter	Estimate	*P*-value	Odds Ratio	Model χ^2	Model *P*-value
% Sage	-0.0286	0.0007	0.9718	70.87, df = 3	≤0.0001
Sage SD[b]	-0.0695	0.0002	0.9328		
Other shrub height (in.)	-0.0365	0.0004	0.9642		

[b] SD = standard deviation.

Habitat associations for Horned Larks at Craters were comparable to results from our statewide survey. Throughout the southern Idaho study area, we found that the most important factors associated with horned lark presence were percent sagebrush cover and mean sagebrush height Table 6). Horned Lark presence was negatively correlated with these two variables, so that as percent cover of sagebrush and sagebrush height increased, Horned Larks were less likely to be present at a site. Across the study area, for every one-percent increase in sagebrush cover, or one-inch increase in mean sagebrush height, the odds that Horned Larks were present at a site decreased by 2.58% and 1.84%, respectively.

Table 6. Results from logistic regression analysis for Horned Lark, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Horned Lark Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
% Sage	0.842	(0.761, 0.930)
Sagebrush Height (in.)	0.926	(0.863, 0.994)

Western Meadowlark

Western Meadowlarks are found in grasslands, shrubsteppe, agricultural areas, and open woodlands of western North America (Lanyon 1994). Typically, Western Meadowlarks are associated with greater herbaceous cover and litter, and sparse shrub cover (Lanyon 1994, Wiens and Rotenberry 1981). A recent trend analysis of BBS data suggests that Western Meadowlarks have experienced short-term population declines throughout the Western BBS region (Dobkin and Sauder 2004). Furthermore, routes within the Columbia Plateau have also experienced significant short-term declines (Dobkin and Sauder 2004).

Western Meadowlarks were very common during this study and were present at every Craters study site and 57 out of 63 sampling plots (n = 781; Table 1). Western Meadowlarks were most abundant at sites L31 (n = 74), L33 (n = 64), L42 (n = 59), C23 (n = 57), and C25 and C29 (both sites n = 53; Table 1; Fig. 5). At Craters, Western Meadowlarks were present at plots where sagebrush cover ranged from 0.0% to 13.5% (mean = 4.64%), where forb cover ranged from 0.83% to 11.5% (mean = 5.53%), and where grass cover ranged from 3.33% to 23.2% (mean = 14.36%; Table 7).

Table 7. Summary of vegetation variables at plots where Western Meadowlarks were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Western Meadowlark: Number of Plots Present = 57

Vegetation Parameter	Mean	SD	Minimum	Maximum
Elevation (m)	1476.81	122.77	1272.25	1810.63
% Shrub Cover	6.23	3.78	0.08	14.00
Shrub Height (in.)	23.73	6.73	13.80	38.30
% Sagebrush Cover	4.64	3.59	0.00	13.50
Sagebrush Height (in.)	26.30	9.35	0.00	44.10
Sagebrush Height Diversity Index (SD)	10.85	4.12	0.00	24.74
% Forb Cover	5.53	2.53	0.83	11.50
Forb Height (in.)	5.32	2.15	2.10	11.60
% Annual Forb Cover	3.31	2.01	0.20	8.10
Annual Forb Height (in.)	3.96	1.89	1.10	9.00
% Perennial Forb Cover	2.22	1.66	0.30	9.60
Perennial Forb Height (in.)	6.58	2.81	1.67	13.70
% Grass Cover	14.36	3.90	3.33	23.20
Grass Height (in.)	7.05	2.69	2.10	13.10
% Annual Grass Cover	5.92	3.44	0.40	15.30
Annual Grass Height (in.)	5.13	2.01	2.00	10.40
% Perennial Grass Cover	8.45	3.06	2.60	15.60
Perennial Grass Height (in.)	8.06	3.05	2.20	16.80
% Litter	3.13	1.37	0.80	9.00
% BARE	11.09	2.92	6.00	22.20

At Craters, Western Meadowlarks were evenly distributed throughout the study area. Their presence was positively associated with forb and grass cover, the amount of litter, and the height of other shrubs, and they were negatively associated with grass height (Table 8). To further interpret results, for every one-percent increase in forb cover, the odds that Western Meadowlarks were present increased (because the estimate is positive) by 2.41%. Similarly, as grass cover and litter increased by one percent, the odds that Western Meadowlarks were present increased by 4.99% and 2.78%, respectively. As mean grass height increased by one inch at a site, the odds that Western Meadowlarks were present decreased by 13.33%. In addition, as the mean height of shrubs other than sagebrush increased by one inch, the odds of Western Meadowlarks being present increased by 1.97%. The presence of shrubs other than sagebrush was typically an indication of disturbance at a site. Rabbitbrush (*Chrysothamnus spp*.) was the predominant shrub at highly disturbed sites, and these sites typically had greater cover of grass, forbs, and litter than less-disturbed sites.

Figure 5. Relative abundance and location of sampling plots where Western Meadowlarks were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

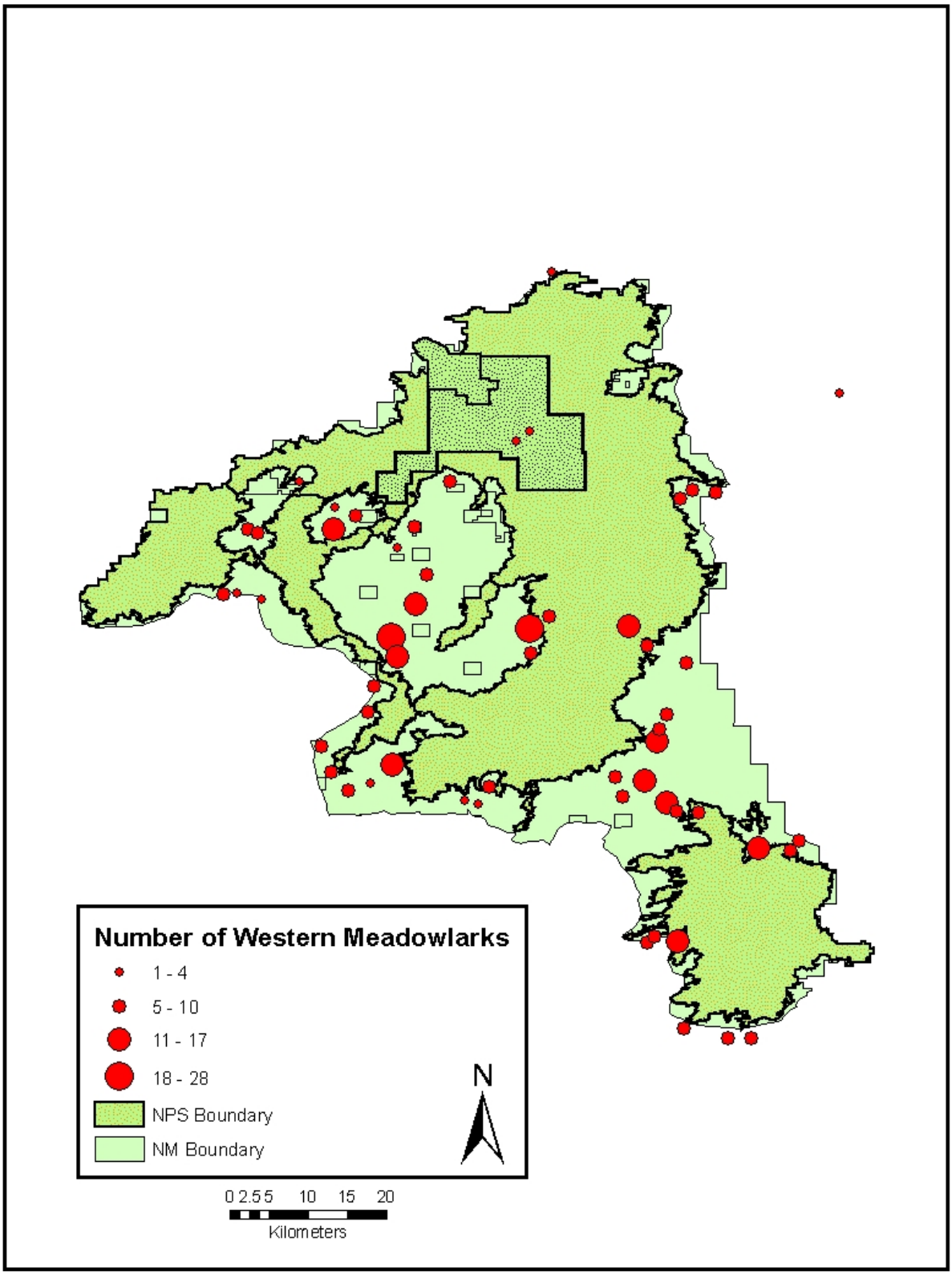


Table 8. Results from logistic regression analysis for Western Meadowlark, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Western Meadowlark Logistic Regression Results: Craters

Vegetation Parameter	Estimate	*P*-value	Odds Ratio	Model χ^2	Model *P*-value
% Forb	0.0239	0.0084	1.0241	92.96, df = 5	≤0.0001
% Grass	0.0487	≤0.0001	1.0499		
% Litter	0.0274	0.0778	1.0278		
Grass height (in.)	-0.1431	≤0.0001	0.8667		
Other shrub height (in.)	0.0195	0.0622	1.0197		

With a few exceptions, habitat associations for Western Meadowlarks at Craters were comparable to results from our statewide survey. Throughout the southern Idaho study area, we found that the most important factors associated with Western Meadowlark presence and abundance were elevation, mean sagebrush height, standard deviation of sagebrush heights, mean grass height, and litter (Table 9). Throughout southern Idaho, Western Meadowlarks were positively correlated with mean sagebrush height, standard deviation of sagebrush heights, and mean grass height, and negatively correlated with elevation and litter. As sagebrush height increased, and as sagebrush heights within a stand became more diverse, Western Meadowlarks were more likely to be present. Likewise, as grass height increased, meadowlarks were more likely to be present. Specifically, for every one-inch increase in mean grass height, and every one-unit increase in standard deviation of sagebrush height, the odds that Western Meadowlarks would be present at a site increased by 3.3% and 26%, respectively (Table 9). In addition, as elevation increased by one meter, mean sagebrush height increased by one inch, and litter increased by one percent, the odds that Western Meadowlarks would be present at a site decreased by 0.03%, 0.74%, and 30.9%, respectively (Table 9). Both at Craters and throughout the study area, Western Meadowlarks were more likely to be present at a site as shrub height and grass cover or grass height increased.

Table 9. Results from logistic regression analysis for Western Meadowlark, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Western Meadowlark Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
Elevation (m)	0.997	(0.994-0.999)
Sagebrush Height (in.)	0.926	(0.863, 0.994)
Sage SD[b]	1.262	(1.097-1.125)
Grass Height (in.)	1.033	(1.008-1.060)
% Litter	0.691	(0.902-0.974)

[b] SD = standard deviation

Brewer's Sparrow

The Brewer's Sparrow is a shrubsteppe obligate passerine, typically found in landscapes dominated by sagebrush, pinyon juniper, or mountain mahogany woodlands (Rotenberry et al. 1999). Throughout the species' range, Brewer's Sparrows are associated with shrub cover, bare

ground, shrub height, patch size, and habitat heterogeneity (Wiens and Rotenberry 1980, 1981). A recent trend analysis of BBS data suggests that Brewer's Sparrows have declined significantly over the long term (1968-2001) in the Western BBS region (Dobkin and Sauder 2004). Furthermore, routes within the Columbia Plateau have also experienced significant declines since 1968 (Dobkin and Sauder 2004).

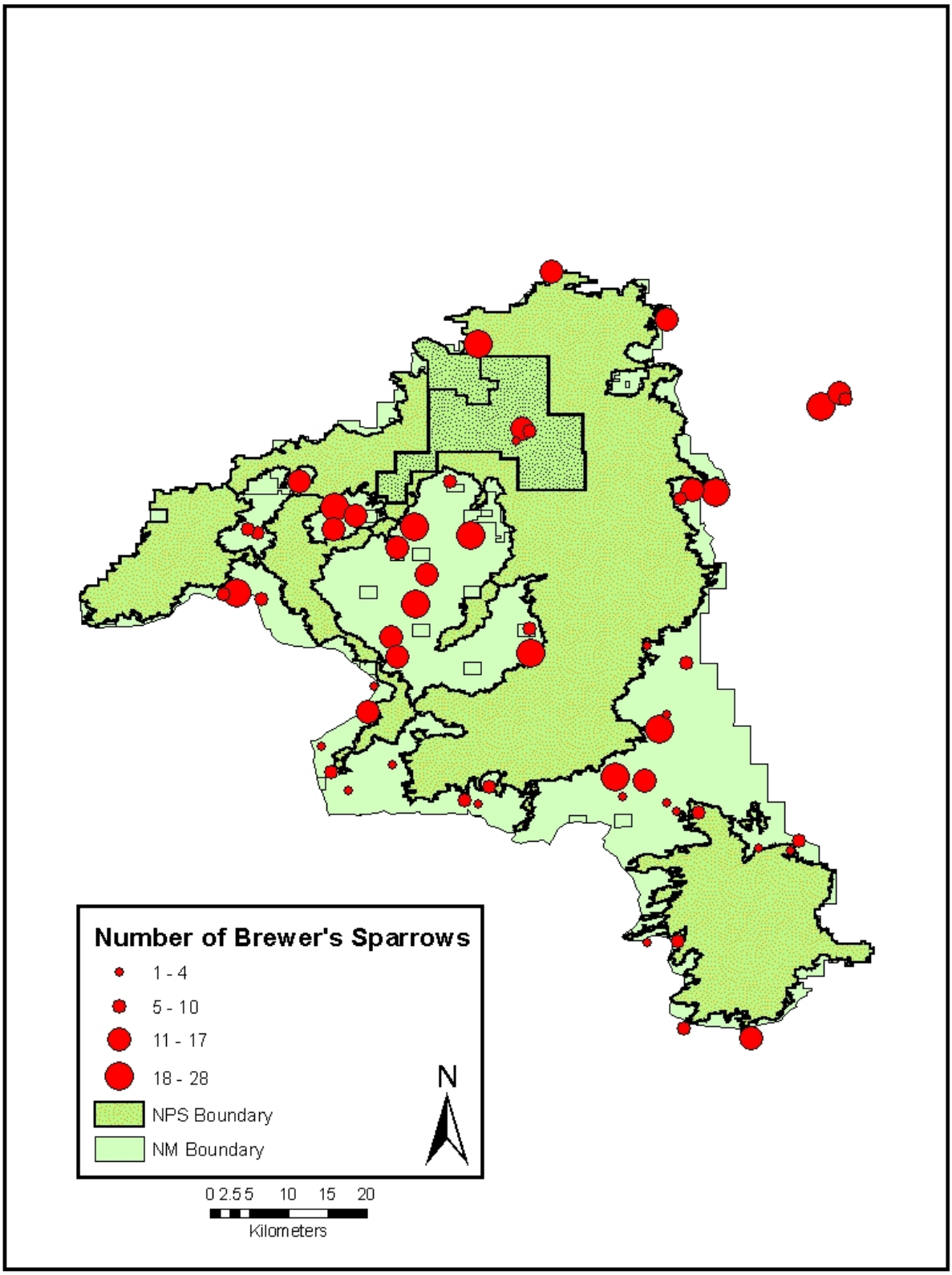
Brewer's Sparrows were very common at Craters during this study and were present at every study site and 57 out of 63 sampling plots (n = 711; Table 1). Brewer's Sparrows were most abundant at sites C20 (n = 59), C16 (n = 58), C15 (n = 57), C39 (n = 54), and A2 (n = 53; Table 1; Fig. 6). Brewer's Sparrows were present at plots where sagebrush cover ranged from 0.0% to 13.5% (mean = 5.01%), where forb cover ranged from 0.83% to 11.5% (mean = 5.56%), and where grass cover ranged from 3.33% to 23.2% (mean = 13.35%; Table 10).

Table 10. Summary of vegetation variables at plots where Brewer's Sparrow were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Brewer's Sparrow: Number of Plots Present = 57

Vegetation Parameter	Mean	SD	Minimum	Maximum
Elevation (m)	1496.12	127.87	1272.25	1810.63
% Shrub Cover	6.86	3.99	0.08	15.25
Shrub Height (in.)	22.97	6.61	13.80	38.30
% Sagebrush Cover	5.01	3.59	0.00	13.50
Sagebrush Height (in.)	25.63	8.65	0.00	44.10
Sagebrush Height Diversity Index (SD)	10.35	4.06	0.00	24.74
% Forb Cover	5.56	2.31	0.83	11.50
Forb Height (in.)	5.20	2.08	2.10	11.60
% Annual Forb Cover	3.33	2.00	0.30	8.10
Annual Forb Height (in.)	4.05	1.84	1.10	9.00
% Perennial Forb Cover	2.22	1.37	0.30	6.50
Perennial Forb Height (in.)	6.43	2.70	1.67	13.70
% Grass Cover	13.35	4.43	3.33	23.20
Grass Height (in.)	7.31	2.88	2.10	14.20
% Annual Grass Cover	5.31	3.69	0.00	15.30
Annual Grass Height (in.)	5.28	2.25	0.00	10.40
% Perennial Grass Cover	8.05	2.95	2.60	15.60
Perennial Grass Height (in.)	8.23	3.11	2.20	16.80
% Litter	3.13	1.37	0.80	9.00
% BARE	11.29	3.02	6.00	22.20

Figure 6. Relative abundance and location of sampling plots where Brewer's Sparrows were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.



At Craters, Brewer's Sparrows were positively associated with sagebrush cover and height and the height of other shrubs, and they were negatively associated with bare ground and grass cover (Table 11). To further interpret results, for every one-percent increase in bare ground, the odds that Brewer's Sparrows were present decreased by 1.51%. Similarly, as grass cover increased by one percent, the odds that Brewer's Sparrows were present decreased by 1.69%. As sagebrush cover increased by one percent and mean sagebrush height and the height of other shrubs increased by one inch, the odds that Brewer's Sparrows were present increased by 4.42%, 2.97%, and 2.97%, respectively. Because Brewer's Sparrows are a sagebrush-obligate species, we would expect them to be closely associated with cover and height of sagebrush and other shrubs. However, contrary to the habitat requirements of this species presented in the scientific literature, they were negatively associated with bare ground at Craters.

Table 11. Results from logistic regression analysis for Brewer's Sparrow, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Brewer's Sparrow Logistic Regression Results: Craters

Vegetation Parameter	Estimate	*P*-value	Odds Ratio	Model χ^2	Model *P*-value
% BARE[a]	-0.0152	0.1135	0.9849	84.93, df = 5	≤0.0001
% Grass	-0.0187	0.0249	0.9831		
% Sage	0.0433	≤0.0001	1.0442		
Sage height (in.)	0.0224	0.0090	1.0297		
Other shrub height (in.)	0.0293	0.0061	1.0297		

[a] BARE = bare ground, rock, and biological soil crusts.

Habitat associations for Brewer's Sparrows at Craters were comparable to results from our statewide survey. Throughout southern Idaho, we found that the most important factors associated with Brewer's Sparrow presence were elevation, percent sagebrush cover, and the standard deviation of sagebrush heights (Table 12). Brewer's Sparrows were positively associated with elevation and percent sagebrush cover, and negatively associated with the standard deviation of sagebrush heights. Thus, as elevation and sagebrush height at sample sites increased, Brewer's Sparrows were more likely to be present. In contrast, as the standard deviation of sagebrush heights increased, or as shrub stands became less uniform, Brewer's Sparrows were less likely to be present. This species seemed to prefer shrub stands which were more homogeneous with regard to shrub heights, and thus was commonly found in early- to mid-successional stands recovering from fire. Specifically, as elevation increased by one meter and as mean sagebrush height within a stand increased by one inch, or as shrub height diversity decreased by one standard deviation, Brewer's Sparrows were 0.4%, 24.9%, and 12.7% more likely to be found at a site.

Table 12. Results from logistic regression analysis for Brewer's Sparrow, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Brewer's Sparrow Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
Elevation (m)	1.004	(1.001-1.006)
% Sagebrush Cover	1.249	(1.061-1.470)
Sage SD[b]	0.873	(0.795-0.960)

[b] SD = standard deviation

Sage Thrasher

The Sage Thrasher is also a shrubsteppe obligate, and is typically found in landscapes dominated by big sagebrush (Reynolds et al. 1999). Throughout the species' range, Sage Thrashers are associated with increasing shrub cover and patch size, and decreasing grass cover (Wiens and Rotenberry 1981). A recent trend analysis of BBS data suggests that Sage Thrasher populations are mixed in the Western BBS region (Dobkin and Sauder 2004). Some areas exhibited no population trends, while others showed significant declines. Routes within the Columbia Plateau have experienced significant long-term (1968-2001) declines (Dobkin and Sauder 2004).

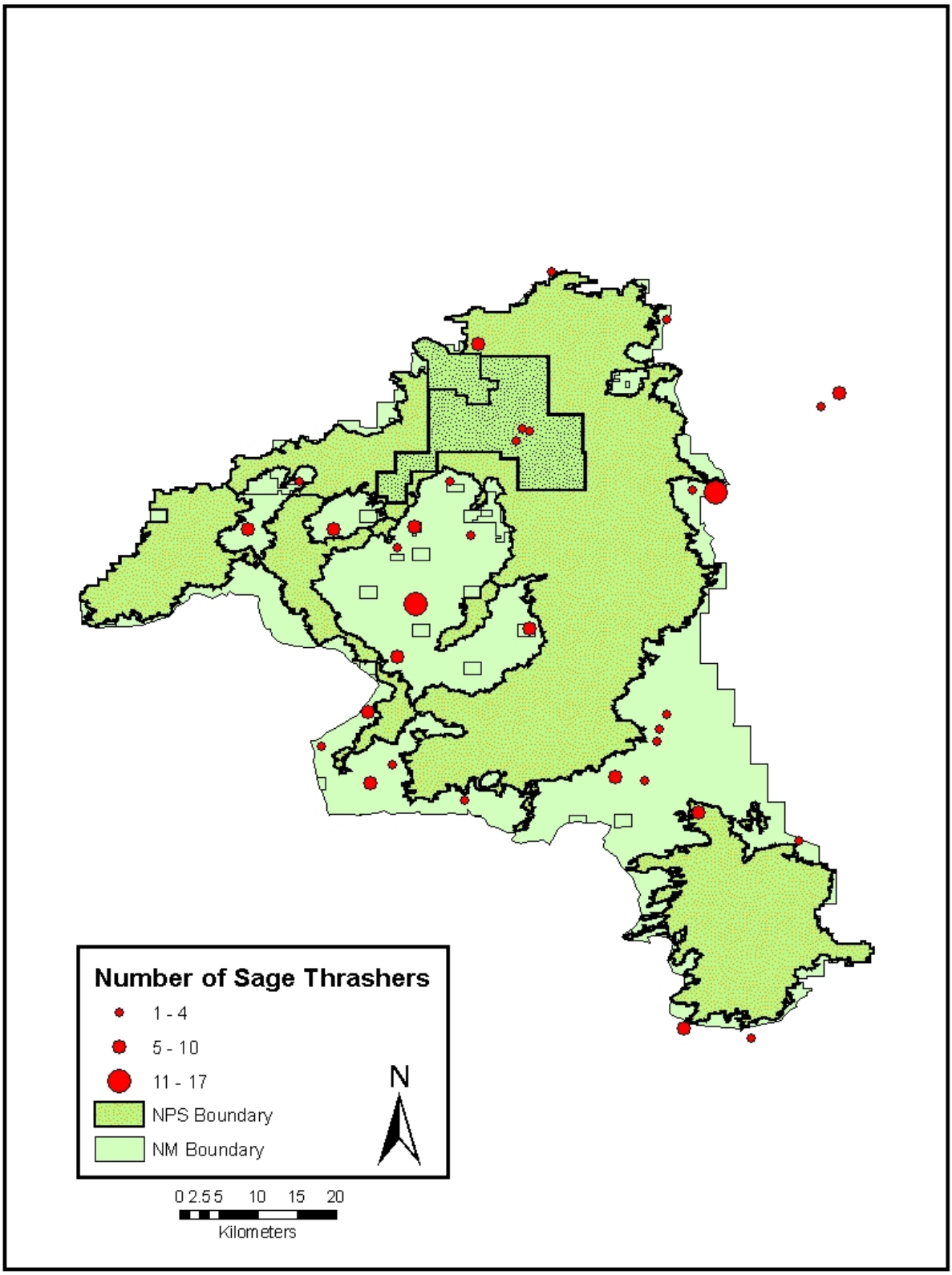
At Craters, Sage Thrashers were less common during this study than some of the other shrubsteppe obligates, but were still present at 20 out of 21 study sites and 34 out of 63 sampling plots (n = 193; Table 1). Sage Thrashers were most abundant at sites C20 (n = 21), C30 (n = 18), C38 (n = 17), A2 (n = 16), and C39 (n = 13; Table 1; Fig. 7). Sage Thrashers were present at plots where sagebrush cover ranged from 0.33% to 11.0% (mean = 5.56%), where forb cover ranged from 1.2% to 11.5% (mean = 5.54%), and where grass cover ranged from 3.33% to 23.2% (mean = 13.05%; Table 13).

Table 13. Summary of vegetation variables at plots where Sage Thrashers were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Sage Thrasher: Number of Plots Present = 34

Vegetation Parameter	Mean	SD	Minimum	Maximum
Elevation (m)	1521.66	150.78	1272.25	1810.63
% Shrub Cover	7.71	4.07	0.42	15.25
Shrub Height (in.)	23.97	6.71	14.90	38.30
% Sagebrush Cover	5.56	3.33	0.33	11.00
Sagebrush Height (in.)	26.97	7.72	15.60	44.10
Sagebrush Height Diversity Index (SD)	10.68	4.10	5.00	24.74
% Forb Cover	5.54	2.48	1.20	11.50
Forb Height (in.)	5.43	2.08	2.10	11.60
% Annual Forb Cover	3.25	1.95	0.40	8.10
Annual Forb Height (in.)	4.45	2.04	1.10	9.00
% Perennial Forb Cover	2.30	1.53	0.30	6.50
Perennial Forb Height (in.)	6.55	2.87	1.67	13.70
% Grass Cover	13.05	5.08	3.33	23.20
Grass Height (in.)	7.52	2.84	2.10	14.20
% Annual Grass Cover	5.18	4.46	0.00	15.30
Annual Grass Height (in.)	5.61	2.35	0.00	10.40
% Perennial Grass Cover	7.88	3.10	2.60	15.60
Perennial Grass Height (in.)	8.13	2.87	2.20	14.80
% Litter	3.14	1.12	0.80	5.60
% BARE	11.04	3.22	6.00	22.20

Figure 7. Relative abundance and location of sampling plots where Sage Thrashers were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.



At Craters, Sage Thrashers were positively associated with sagebrush height, sagebrush height diversity, and percent cover of other shrubs at Craters sites (Table 14). For every one-inch increase in mean sagebrush height, the odds that Sage Thrashers were present increased by 2.47%. Similarly, as the diversity of sagebrush heights increased by one standard deviation, the odds that Sage Thrashers were present increased by 6.99%. And, as the density of other shrubs increased by one percent, the odds that Sage Thrashers were present increased by 6.79%.

Table 14. Results from logistic regression analysis for Sage Thrasher, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Sage Thrasher Logistic Regression Results: Craters

Vegetation Parameter	Estimate	*P*-value	Odds Ratio	Model χ^2	Model *P*-value
Sage height (in.)	0.0244	0.0489	1.0247	42.24, df = 3	≤0.0001
Sage SD[b]	0.0676	0.0059	1.0699		
% Other shrubs	0.0657	0.0007	1.0679		

[b] SD = standard deviation.

Habitat associations for Sage Thrashers at Craters were also comparable to results from our statewide survey. Throughout southern Idaho, we found that the most important factors associated with Sage Thrasher presence were elevation, percent sagebrush cover, and mean sagebrush height (Table 15). Sage Thrashers were positively associated with all three of these variables. Thus, as elevation, sagebrush cover, and sagebrush height increased, Sage Thrashers were more likely to be present at sample sites. Specifically, as elevation increased by one meter, as sagebrush cover increased by one percent, and as mean sagebrush height within a stand increased by one inch, Sage Thrashers were 0.2%, 18.6%, and 8.9% more likely to be found at a site. Like Brewer's Sparrows, Sage Thrashers are a sagebrush-obligate species, and we would expect them to be closely associated with cover and height of sagebrush and other shrubs. In addition, our data suggest that Sage Thrashers are associated with shrub stands that have greater diversity in shrub heights rather than stands with more uniform shrub heights. As a general rule, across our study area, as elevation increased, shrub densities and shrub heights also increased.

Table 15. Results from logistic regression analysis for Sage Thrasher, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Sage Thrasher Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
Elevation (m)	1.004	(1.001-1.006)
% Sagebrush Cover	1.249	(1.061-1.470)
Sage SD[b]	0.873	(0.795-0.960)

[b] SD = standard deviation.

Lark Sparrow

Lark Sparrows are found in open landscapes throughout central and western North America, including shrubsteppe, grasslands, and open woodlands (Martin and Parrish 2000). Throughout the species' range, Lark Sparrows prefer sparse to moderate shrub cover, bare ground, and patches of herbaceous cover (Martin and Parrish 2000). Lark Sparrows often select distinct ecotones, or abrupt changes in habitat types. A recent trend analysis of BBS data suggests that Lark Sparrow populations declined in the Western BBS region from 1984-2001 (Dobkin and Sauder 2004). No trends were evident from routes analyzed within the Columbia Plateau, but nonetheless, the overall trend was down for this species.

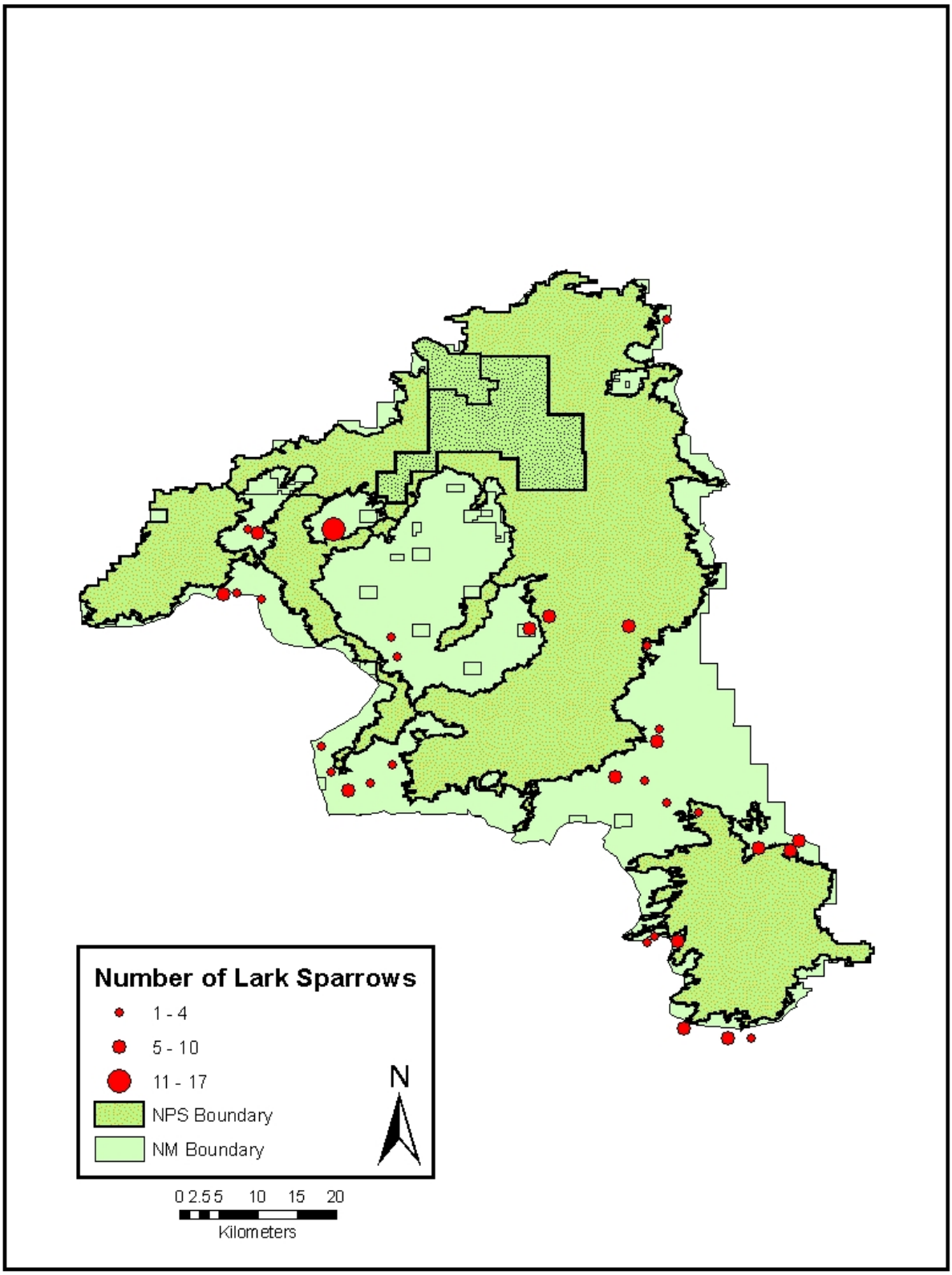
Lark Sparrows were more common at Craters than throughout the rest of the study area. They were present at 17 out of the 21 study sites and 33 out of 63 sampling plots (n = 190; Table 1). Lark Sparrows were most abundant at sites L42 (n = 23), L48 (n = 21), L46 (n = 19), C25 (n = 16), and C11 (n = 14; Table 1; Fig. 8). Lark Sparrows were present at plots where sagebrush cover ranged from 0.0% to 9.9% (mean = 4.29%), where forb cover ranged from 0.83% to 11.5% (mean = 5.22%), and where grass cover ranged from 5.4% to 23.2% (mean = 14.99%; Table 16).

Table 16. Summary of vegetation variables at plots where Lark Sparrows were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Lark Sparrow: Number of Plots Present = 33

Vegetation Parameter	Mean	SD	Minimum	Maximum
Elevation (m)	1433.50	88.33	1302.50	1661.50
% Shrub Cover	5.92	3.58	0.80	11.90
Shrub Height (in.)	25.08	7.57	13.80	38.30
% Sagebrush Cover	4.29	3.28	0.00	9.90
Sagebrush Height (in.)	27.33	10.05	0.00	44.10
Sagebrush Height Diversity Index (SD)	11.37	3.63	3.42	17.89
% Forb Cover	5.22	2.60	0.83	11.50
Forb Height (in.)	5.04	2.05	2.10	9.20
% Annual Forb Cover	3.17	2.21	0.20	8.10
Annual Forb Height (in.)	3.65	2.00	1.10	7.90
% Perennial Forb Cover	2.07	1.73	0.30	9.60
Perennial Forb Height (in.)	6.53	2.53	2.70	12.33
% Grass Cover	14.99	4.00	5.40	23.20
Grass Height (in.)	6.35	2.49	2.10	13.10
% Annual Grass Cover	7.29	3.19	0.00	15.30
Annual Grass Height (in.)	4.25	1.78	0.00	7.60
% Perennial Grass Cover	7.71	2.80	3.33	14.00
Perennial Grass Height (in.)	7.66	3.10	2.20	16.80
% Litter	2.97	1.01	1.20	5.20
% BARE	11.23	2.74	6.40	16.10

Figure 8. Relative abundance and location of sampling plots where Lark Sparrows were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.



At Craters, Lark Sparrows were negatively associated with sagebrush cover, percent cover of other shrubs, and grass height, and positively associated with sagebrush height diversity and height of other shrubs (Table 17). For every one-percent increase in sagebrush cover, the odds that Lark Sparrows were present at a site decreased by 2.3%. Similarly, as the cover of other shrubs increased by one percent, and mean grass height increased by one inch, the odds that Lark Sparrows were present decreased by 4.35%, and 8.34%, respectively. And, as shrub height diversity increased by one standard deviation and the mean height of other shrubs increased by one inch, the odds that Lark Sparrows were present increased by 6.27% and 2.35%, respectively.

Table 17. Results from logistic regression analysis for Lark Sparrow, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Lark Sparrow Logistic Regression Results: Craters

Vegetation Parameter	Estimate	*P*-value	Odds Ratio	Model χ^2	Model *P*-value
% Sagebrush cover	-0.0233	0.0368	0.9770	24.87, df = 5	0.0001
Grass height (in.)	-0.0871	0.0254	0.9166		
Sage SD[b]	0.0608	0.0050	1.0627		
% Other shrubs	-0.0444	0.0844	0.9565		
Other shrub height (in.)	0.0233	0.0676	1.0235		

[b] SD = standard deviation.

Habitat associations for Lark Sparrows at Craters were more well-defined than results from our statewide survey. Throughout southern Idaho, we found that the most important factor associated with Lark Sparrow presence was percent cover of annual grass (Table 18). As annual grass cover increased throughout the study area by one percent, Lark Sparrows were 23.8% more likely to be found there. In contrast, at Craters, Lark Sparrows were generally associated with sites that had less sage or other shrubs, shorter grass, taller shrubs, and greater shrub height diversity. These results are difficult to interpret, however, across the entire study area sites which had greater cover of annual grasses typically did have less shrub cover.

Table 18. Results from logistic regression analysis for Lark Sparrow, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Lark Sparrow Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
% Annual Grass Cover	1.238	(1.083-1.415)

Lark Sparrows are not a shrubteppe obligate species, so we would not expect them to be closely associated with sagebrush or other shrubs. Instead, Lark Sparrows were more commonly associated with poorer sites where some type of structural diversity of the landscape was present. Our impression of this species from field work is that it is more likely to occur at an abrupt change in habitat structure, such as a creek bed, at the base of a hill, near a rock outcrop, or in the case of Craters, it was often associated with exposed lava. Time and time again, we encountered Lark Sparrows in association with structural diversity of the landscape rather than specific vegetation parameters. Furthermore, Lark Sparrows were positively associated with sagebrush height diversity and the height of other shrubs, indicating that vertical structure is important to

this species. These results are not surprising, given this species' common use of ecotonal areas (Martin and Parrish 2000).

Vesper Sparrow

The Vesper Sparrow is a generalist grassland species found in shrubsteppe, prairies, meadows, grasslands, open woodlands, and agricultural areas throughout much of the United States (Jones and Cornely 2002). Throughout the species' range, Vesper Sparrows prefer low shrub cover, short herbaceous vegetation, bare ground, and broad-leafed flowering plants, while avoiding wetter areas with dense vegetation (Dechant et al. 2001). A recent trend analysis of BBS data suggests that Vesper Sparrow populations are stable throughout most of the Western BBS region (Dobkin and Sauder 2004).

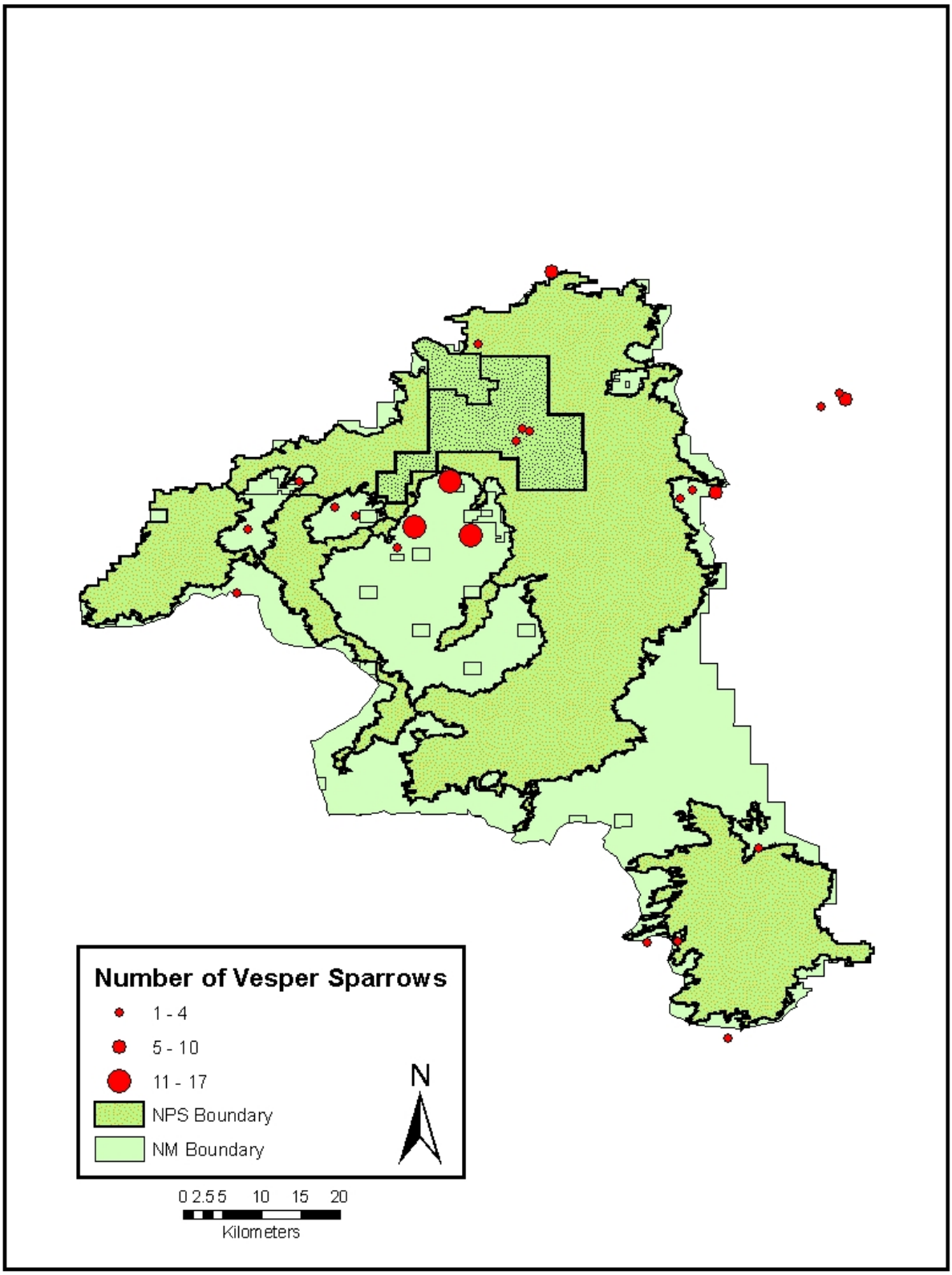
Vesper Sparrows were common at Craters throughout this study. They were present at 12 out of the 21 study sites and 33 out of 63 sampling plots (n = 129; Table 1). Vesper Sparrows were most abundant at sites C16 (n = 42), C39 (n = 18), C38 (n = 15), A2 (n = 13), and C15 (n = 10; Table 1; Fig. 9). Vesper Sparrows were present at plots where sagebrush cover ranged from 0.0% to 13.5% (mean = 6.01%), where forb cover ranged from 0.83% to 11.5% (mean = 5.89%), and where grass cover ranged from 3.33% to 20.3% (mean = 11.6%; Table 19). In general, Vesper Sparrows were more abundant in the more northern portions of the National Monument (Fig. 9).

Table 19. Summary of vegetation variables at plots where Vesper Sparrows were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Vesper Sparrow: Number of Plots Present = 33

Vegetation Parameter	Mean	SD	Minimum	Maximum
Elevation (m)	1559.66	135.69	1305.25	1810.63
% Shrub Cover	8.07	4.42	0.42	15.25
Shrub Height (in.)	21.02	5.43	13.90	36.60
% Sagebrush Cover	6.01	4.09	0.00	13.50
Sagebrush Height (in.)	23.88	9.29	0.00	44.10
Sagebrush Height Diversity Index (SD)	9.32	3.59	5.00	17.89
% Forb Cover	5.89	2.63	0.83	11.50
Forb Height (in.)	5.72	2.07	2.60	11.60
% Annual Forb Cover	3.09	2.00	0.30	7.90
Annual Forb Height (in.)	4.34	1.83	2.10	9.00
% Perennial Forb Cover	2.81	1.58	0.60	6.50
Perennial Forb Height (in.)	6.81	2.50	3.60	13.70
% Grass Cover	11.60	4.74	3.33	20.30
Grass Height (in.)	8.92	2.57	4.00	14.20
% Annual Grass Cover	2.71	2.44	0.40	8.67
Annual Grass Height (in.)	6.46	2.31	2.90	10.40
% Perennial Grass Cover	8.90	3.37	2.60	15.60
Perennial Grass Height (in.)	9.69	2.58	4.30	14.80
% Litter	2.97	1.77	0.80	9.00
% BARE	11.51	3.53	6.10	22.20

Figure 9. Relative abundance and location of sampling plots where Vesper Sparrows were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.



At Craters, Vesper Sparrows were positively associated with sagebrush cover, cover of other shrubs, and grass height, and negatively associated with bare ground, litter, forb height, sagebrush height, and the height of other shrubs (Table 20). For every one-percent increase in bare ground and litter, the odds that Vesper Sparrows were present at a site decreased by 1.89% and 3.43%, respectively. Similarly, as mean forb height, sage height, and other shrub height increased by one inch, the odds that Vesper Sparrows were present also decreased by 8.83%, 2.93%, and 7.08%, respectively. In contrast, as sagebrush cover and the cover of other shrubs increased by one percent, the odds that Vesper Sparrows were present at a site increased by 4.42% and 6.71%, respectively.

Table 20. Results from logistic regression analysis for Vesper Sparrow, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Vesper Sparrow Logistic Regression Results: Craters

Vegetation Parameter	Estimate	*P*-value	Odds Ratio	Model χ^2	Model *P*-value
% BARE [a]	-0.0191	0.1244	0.9811	56.24, df = 8	≤0.0001
% Litter	-0.0349	0.1427	0.9657		
% Sagebrush cover	0.0432	0.0001	1.0442		
Forb height (in.)	-0.0925	0.1030	0.9117		
Grass height (in.)	0.1720	≤0.0001	1.1877		
Sage height (in.)	-0.0297	0.0259	0.9707		
% Other shrubs	0.0649	0.0243	1.0671		
Other shrub height (in.)	-0.0735	0.0015	0.9292		

[a] Bare = bare ground, rock, and biological soil crusts.

Habitat associations for Vesper Sparrows at Craters were more well-defined than results from our statewide survey. Throughout southern Idaho, we found that the most important factors associated with Vesper Sparrow presence were elevation, bare ground, and litter (Table 21). As elevation increased at sites across the study area by one meter, the odds that Vesper Sparrows were present increased by 0.3%. As bare ground and litter increased at sites by one percent, the odds that Vesper Sparrows were present decreased by 16.5% and 19.5%, respectively.

Table 21. Results from logistic regression analysis for Vesper Sparrow, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Vesper Sparrow Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
Elevation (m)	1.003	(1.001-1.005)
% BARE[a]	0.835	(0.738-0.944)
% Litter	0.805	(0.674-0.962)

[b] SD = standard deviation

Because Vesper Sparrows are not a shrub-obligate species and actually prefer grasslands, we would not expect them to be closely associated with sagebrush or other shrubs. As expected, as

shrub heights increased in our study, Vesper Sparrows were less likely to be present. Likewise, as grass height increased, Vesper Sparrows were more likely to be present. Throughout the study area, as elevation increased, sites typically increased in grass cover and height. Their association with percent cover of other shrubs may indicate that they were more likely to be present on disturbed sites where other shrub species were present, namely rabbitbrush. These sites also typically had greater grass cover and height. Vesper Sparrows are widespread throughout the shrubsteppe regions of Idaho, and tend to be closely associated with sites containing good understory grasses rather than bare ground or litter, as indicated by our data.

Grasshopper Sparrow

The Grasshopper Sparrow is found mainly in grasslands of the central and north-central United States (Vickery 1996), and Idaho occurs on the western edge of its range. The species is typically associated with grass cover and homogenous habitat, and is not usually associated with increasing shrub cover and diversity or bare ground. A recent trend analysis of BBS data indicates that Grasshopper Sparrow populations have declined catastrophically throughout the species' range (Dobkin and Sauder 2004). Throughout the Western BBS region, and specifically within the Columbia Plateau, populations have significantly declined over both the long- and short-term (Dobkin and Sauder 2004).

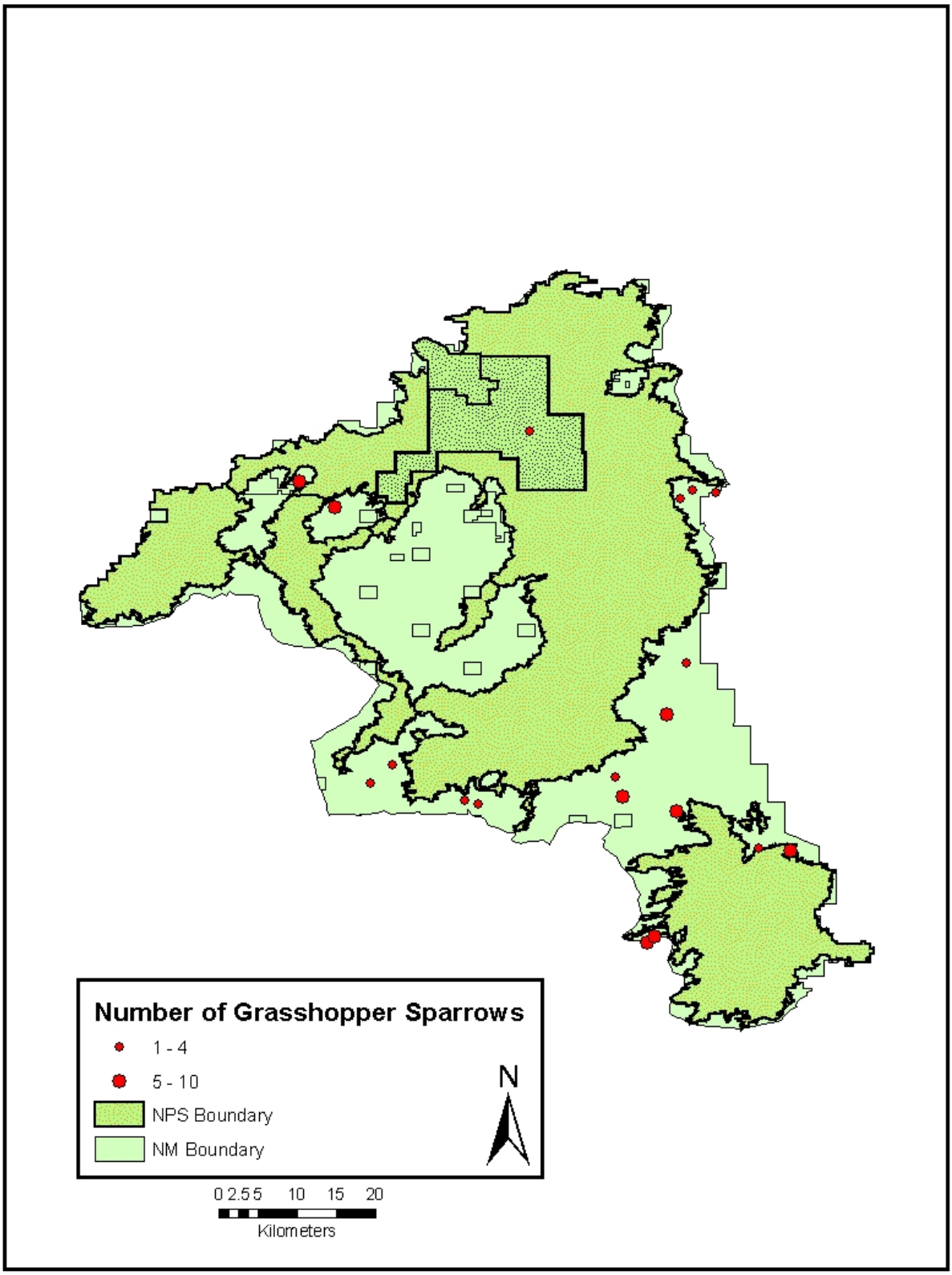
Grasshopper Sparrows were common at Craters throughout this study. They were present at 12 out of the 21 study sites and 20 out of 63 sampling plots (n = 99; Table 1). Grasshopper Sparrows were most abundant at sites L41 (n = 23), L46 (n = 16), L33 (n = 10), and C34 (n = 9; Table 1; Fig. 10). Grasshopper Sparrows were present at plots where sagebrush cover ranged from 0.0% to 9.2% (mean = 2.37%), where forb cover ranged from 3.10% to 11.6% (mean = 5.86%), and where grass cover ranged from 4.5% to 13.10% (mean = 8.66%; Table 22).

Table 22. Summary of vegetation variables at plots where Grasshopper Sparrows were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Grasshopper Sparrow: Number of Plots Present = 20

Vegetation Parameter	Mean	SD	Minimum	Maximum
Elevation (m)	1493.64	130.78	1312.63	1810.63
% Shrub Cover	3.80	3.15	0.08	12.20
Shrub Height (in.)	19.65	4.33	13.80	29.20
% Sagebrush Cover	2.37	2.84	0.00	9.20
Sagebrush Height (in.)	23.06	9.58	0.00	40.30
Sagebrush Height Diversity Index (SD)	5.33	2.72	0.83	9.83
% Forb Cover	5.86	1.95	3.10	11.60
Forb Height (in.)	3.13	1.82	0.20	6.90
% Annual Forb Cover	4.49	1.72	2.00	7.90
Annual Forb Height (in.)	2.22	1.75	0.30	6.50
% Perennial Forb Cover	6.87	3.05	1.67	13.70
Perennial Forb Height (in.)	15.29	3.29	8.40	20.70
% Grass Cover	8.66	2.78	4.50	13.10
Grass Height (in.)	5.23	3.48	0.40	12.33
% Annual Grass Cover	5.94	1.92	3.20	9.60
Annual Grass Height (in.)	10.07	2.98	5.20	15.60
% Perennial Grass Cover	9.78	3.07	3.83	16.80
Perennial Grass Height (in.)	3.54	1.54	1.67	9.00
% Litter	10.92	1.87	6.67	13.33
% BARE	8.89	3.58	0.00	14.31

Figure 10. Relative abundance and location of sampling plots where Grasshopper Sparrows were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.



At Craters, Grasshopper Sparrows were positively associated with grass cover and grass height, and negatively associated with sagebrush height diversity (Table 23). For every one-percent increase in grass cover and every one-inch increase in mean grass height, the odds that Grasshopper Sparrows were present at a site increased by 3.63% and 11.3%, respectively. As the diversity in sagebrush height increased by one unit, the odds that Grasshopper Sparrows were present decreased by 17.31%.

Table 23. Results from logistic regression analysis for Grasshopper Sparrow, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Grasshopper Sparrow Logistic Regression Results: Craters

Vegetation Parameter	Estimate	*P*-value	Odds Ratio	Model χ^2	Model *P*-value
% Grass	0.0357	0.0001	1.0363	83.90, df = 3	≤0.0001
Grass height (in.)	0.1069	0.0073	1.1130		
Sage SD[b]	-0.1900	≤0.0001	0.8269		

[b] SD = standard deviation.

As expected, habitat associations for Grasshopper Sparrows at Craters were similar to results from our statewide survey. At sites throughout southern Idaho, Grasshopper Sparrows were negatively associated with sagebrush cover and annual forb height, and positively associated with grass height (Table 24). As sagebrush cover and annual forb height increased by one percent, the odds that Grasshopper Sparrows would be present decreased by 2.51% and 2.15%, respectively. Also, as mean grass height increased by one inch, the odds that Grasshopper Sparrows were present at a site increased by 42.5%. These results are exactly what you would expect for Grasshopper Sparrows, a grassland species. They were most closely associated with grass variables and the lack of shrubs and shrub height diversity.

Table 24. Results from logistic regression analysis for Grasshopper Sparrow, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Grasshopper Sparrow Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
% Sage Cover	0.749	(0.618-0.908)
Annual Forb Height	0.785	(0.665-0.926)
Grass Height	1.425	(1.130-1.798)

Sage Sparrow

The Sage Sparrow is a shrubsteppe obligate species associated with big sagebrush (Martin and Carlson 1998). The species' presence is positively associated with increasing shrub cover and bare ground, and negatively associated with grass cover (Knick and Rotenberry 1995). Curiously, in contrast to the other shrubsteppe obligates, a recent trend analysis of BBS data indicates that Sage Sparrow populations are stable (Dobkin and Sauder 2004). Throughout the Western BBS region, and specifically within the Columbia Plateau, short-term (1984-2001) population trends are stable or increasing (Dobkin and Sauder 2004).

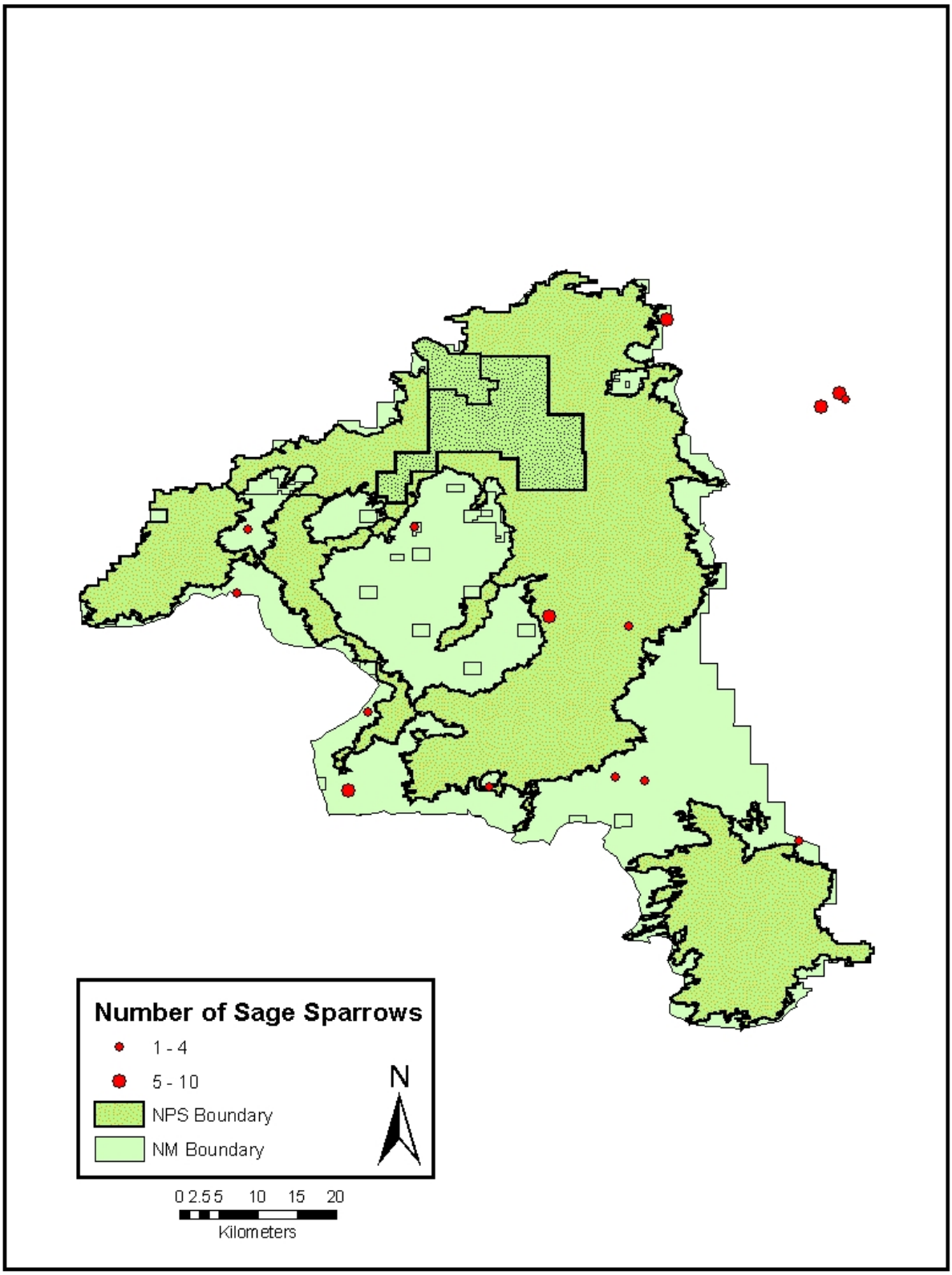
At Craters, Sage Sparrows were not common, but they were not rare, either. Sage Sparrows were present at 14 out of the 21 study sites and 15 out of 63 sampling plots (n = 74; Table 1). Sage Sparrows were most abundant at sites C39 (n = 28), A2 (n = 12), C25 (n = 9), and C29 (n = 5; Table 1; Fig. 11). Sage Sparrows were present at plots where sagebrush cover ranged from 1.9% to 10.0% (mean = 6.71%), where forb cover ranged from 2.8% to 11.5% (mean = 5.68%), and where grass cover ranged from 4.3% to 18.2% (mean = 11.38%; Table 25).

Table 25. Summary of vegetation variables at plots where Sage Sparrows were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Sage Sparrow: Number of Plots Present = 15

Vegetation Parameter	Mean	SD	Minimum	Maximum
Elevation (m)	1508.05	110.19	1307.88	1771.38
% Shrub Cover	8.76	2.74	2.80	11.90
Shrub Height (in.)	23.51	7.29	14.00	36.60
% Sagebrush Cover	6.71	2.63	1.90	10.00
Sagebrush Height (in.)	25.57	8.32	15.60	44.10
Sagebrush Height Diversity Index (SD)	10.74	3.61	6.11	17.89
% Forb Cover	5.68	2.73	2.80	11.50
Forb Height (in.)	5.38	1.98	2.60	9.20
% Annual Forb Cover	2.90	2.32	0.40	8.10
Annual Forb Height (in.)	3.69	1.57	1.60	7.20
% Perennial Forb Cover	2.70	2.08	1.00	9.60
Perennial Forb Height (in.)	6.63	2.32	3.90	10.40
% Grass Cover	11.38	4.10	4.30	18.20
Grass Height (in.)	6.71	2.47	3.40	12.80
% Annual Grass Cover	4.28	3.09	0.00	8.60
Annual Grass Height (in.)	4.98	2.17	0.00	8.33
% Perennial Grass Cover	7.09	1.87	3.80	9.80
Perennial Grass Height (in.)	7.11	2.77	3.00	12.80
% Litter	3.28	1.27	1.20	5.60
% BARE	11.94	3.38	6.40	16.20

Figure 11. Relative abundance and location of sampling plots where Sage Sparrows were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.



At Craters, Sage Sparrows were positively associated with bare ground, cover of sagebrush and other shrubs, sagebrush height diversity, and forb height, but were negatively associated with sagebrush height (Table 26). For every one-percent increase in bare ground, sagebrush cover, and cover of other shrubs, the odds that Sage Sparrows were present at a site increased by 9.33%, 7.34%, and 7.94%, respectively. For every one-unit increase in sagebrush height diversity, and for every one-inch increase in mean forb height, the odds that Sage Sparrows were present at a site increased by 15.54% and 13.05%, respectively. Lastly, as mean sagebrush height increased by one inch, the odds that Sage Sparrows were present decreased by 5.67%.

Table 26. Results from logistic regression analysis for Sage Sparrow, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Sage Sparrow Logistic Regression Results: Craters

Vegetation Parameter	Estimate	*P*-value	Odds Ratio	Model χ^2	Model *P*-value
% BARE [a]	0.0892	≤0.0001	1.0933	56.05, df = 6	≤0.0001
% Sage	0.0708	≤0.0001	1.0734		
Forb height	0.1227	0.0509	1.1305		
Sage height	-0.0584	0.0581	0.9433		
Sage SD [b]	0.1444	0.0063	1.1554		
% Other shrubs	0.0764	0.0194	1.0794		

[a] Bare = bare ground, rock, and biological soil crusts.
[b] SD = standard deviation.

Habitat associations for Sage Sparrows at Craters were roughly similar to results from our statewide survey. At sites throughout southern Idaho, Sage Sparrows were negatively associated with elevation and sagebrush height diversity, and positively associated with sagebrush cover, sagebrush height, and bare ground (Table 27). As elevation increased by one meter and sagebrush height diversity increased by one unit, the odds that Sage Sparrows were present at a site decreased by 0.3% and 16.3%, respectively. As sagebrush cover increased by one percent, mean sagebrush height increased by one inch, and bare ground increased by one percent, the odds that Sage Sparrows were present at a site increased by 50.2%, 19.0%, and 43.8%, respectively.

Sage Sparrows are a true sagebrush obligate species and we would expect their presence to be closely associated with shrub cover, especially sagebrush cover. Perhaps most important for this species is its close association with bare ground. Sage Sparrows are ground feeders and are more likely to be present as bare ground increases. Because of these habitat relationships, Sage Sparrows may represent the greatest challenge for shrubsteppe land managers, as the spread of invasive exotic annual grasses and forbs are quickly eliminating bare ground within the understories of remaining sagebrush stands in Idaho.

Table 27. Results from logistic regression analysis for Sage Sparrow, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Sage Sparrow Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
Elevation	0.997	(0.995-0.999)
% Sage	1.502	(0.292-1.746)
Sage height	1.19	(1.067-1.327)
Sage SD[b]	0.837	(0.736-0.953)
% BARE[a]	1.438	(1.273-1.624)

[a] Bare = bare ground, rock, and biological soil crusts.

Loggerhead Shrike

Loggerhead Shrikes are found throughout much of North America in open woodlands and shrubsteppe, as well as agricultural and riparian areas (Yosef 1996). They are typically associated with increasing shrub density, diversity, and height, and also with abundant bare ground and sparse herbaceous cover (Yosef 1996, Wiens and Rotenberry 1981). A recent analysis of BBS data reveals that Loggerhead Shrikes have declined throughout much of their range (Dobkins and Sauder 2004). In the Western BBS region and within the Columbia Plateau, populations have also declined significantly since 1968 (Dobkins and Sauder 2004).

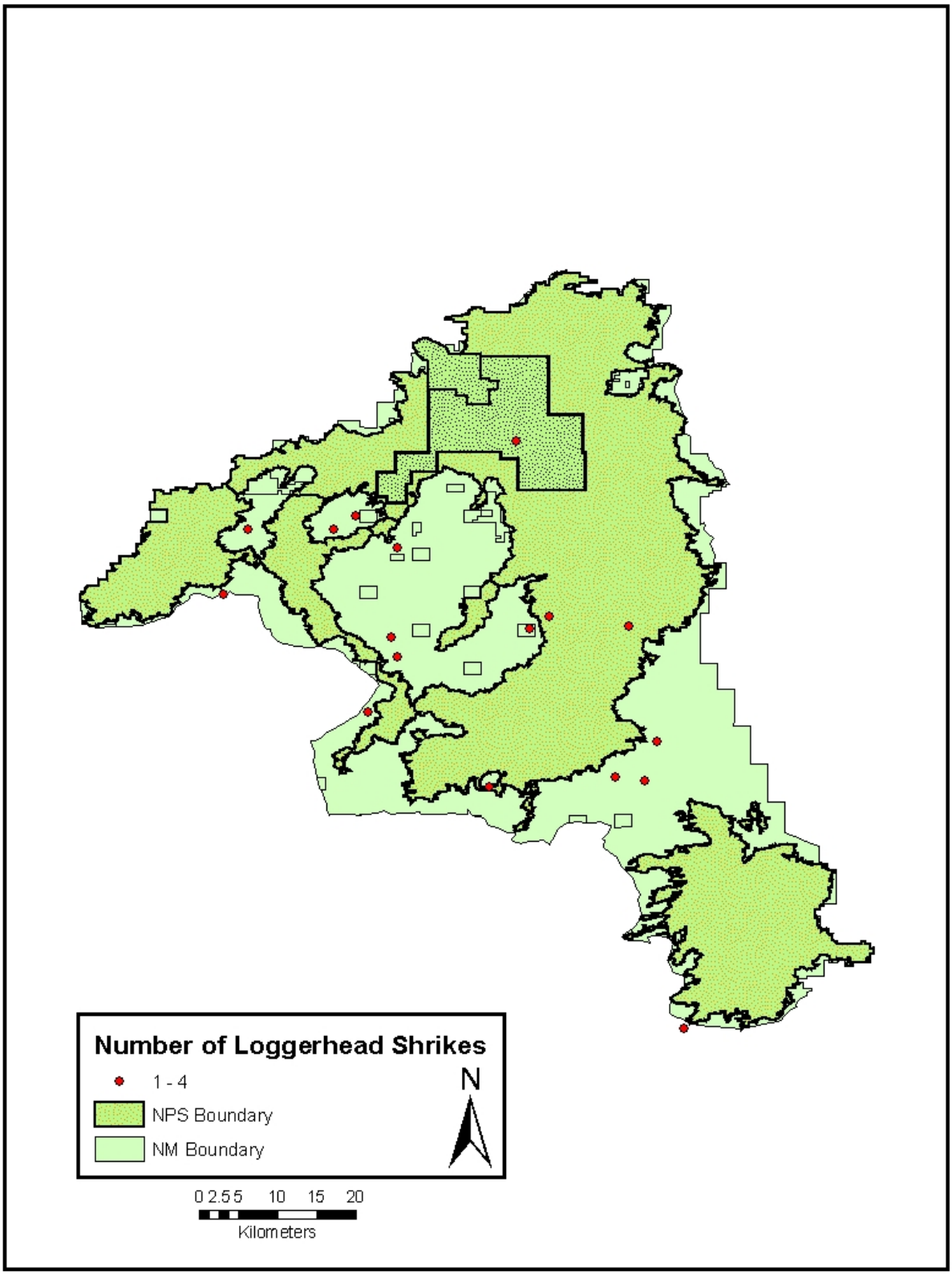
Loggerhead Shrikes were uncommon and widely distributed, but not rare at Craters throughout this study. They were present at 16 out of the 21 study sites and 17 out of 63 sampling plots (n = 42; Table 1). Loggerhead Shrikes were most abundant at sites C25 and C34 (both sites n = 6), and C15 and C23 (both sites n = 5; Table 1; Fig. 12). Loggerhead Shrikes were present at plots where sagebrush cover ranged from 0.33% to 13.5% (mean = 6.34%), where forb cover ranged from 1.8% to 11.5% (mean = 5.95%), and where grass cover ranged from 3.33% to 18.9% (mean = 14.21%; Table 28).

Table 28. Summary of vegetation variables at plots where Loggerhead Shrikes were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Loggerhead Shrikes: Number of Plots Present = 17

Vegetation Parameter	Mean	SD	Minimum	Maximum
Elevation (m)	1482.75	99.83	1302.50	1712.13
% Shrub Cover	8.01	3.74	0.42	14.00
Shrub Height (in.)	28.82	5.51	17.20	38.30
% Sagebrush Cover	6.34	3.48	0.33	13.50
Sagebrush Height (in.)	31.05	6.83	16.80	44.10
Sagebrush Height Diversity Index (SD)	12.97	3.00	5.85	17.89
% Forb Cover	5.95	2.69	1.80	11.50
Forb Height (in.)	4.93	2.08	2.40	9.20
% Annual Forb Cover	3.78	2.20	1.00	8.10
Annual Forb Height (in.)	3.40	1.40	1.60	6.50
% Perennial Forb Cover	2.11	2.09	0.30	9.60
Perennial Forb Height (in.)	6.42	2.52	2.70	10.40
% Grass Cover	14.21	3.75	3.33	18.90
Grass Height (in.)	6.00	1.95	3.20	9.60
% Annual Grass Cover	6.77	2.79	0.80	11.40
Annual Grass Height (in.)	4.77	1.56	2.00	7.10
% Perennial Grass Cover	7.46	2.54	2.60	11.90
Perennial Grass Height (in.)	7.06	2.33	3.00	10.70
% Litter	2.98	1.16	0.80	5.20
% BARE	10.94	3.78	6.40	22.20

Figure 12. Relative abundance and location of sampling plots where Loggerhead Shrikes were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.



At Craters, Loggerhead Shrikes were positively associated with sagebrush height diversity, and negatively associated with mean grass height (Table 29). For every one-unit increase in sagebrush height diversity, the odds that Loggerhead Shrikes were present at a site increased by 12.56%. As mean grass height increased by one inch, the odds that Loggerhead Shrikes were present at a site decreased by 16.23%.

Table 29. Results from logistic regression analysis for Loggerhead Shrike, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Loggerhead Shrike Logistic Regression Results: Craters

Vegetation Parameter	Estimate	*P*-value	Odds Ratio	Model χ^2	Model *P*-value
Grass height (in.)	-0.1771	0.0483	0.8377	16.69, df = 2	0.0002
Sage SD [b]	0.1183	0.0014	1.1256		

[b] SD = standard deviation.

Habitat associations for Loggerhead Shrikes at Craters were only roughly similar to results from our statewide survey. In common with Craters, at sites throughout southern Idaho, Loggerhead Shrikes were positively associated with sagebrush height diversity (Table 30). However, shrikes were also associated with annual forb and grass cover. As annual forb or grass cover increased by one percent, the odds that Loggerhead Shrikes were present at a site increased by 35.3% and 20.5%, respectively. These results are hard to interpret or explain. Lastly, in accordance with the species' general habitat requirements throughout its range, we found that Loggerhead Shrike presence was also associated with bare ground. As bare ground increased by one percent at sites, the odds that Loggerhead Shrikes were present increased by 20.7%.

Table 30. Results from logistic regression analysis for Loggerhead Shrike, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Loggerhead Shrike Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
Sage SD[b]	1.172	(1.057-1.299)
% Annual Forb	1.353	(1.086-1.687)
% Annual Grass	1.205	(1.038-1.400)
% BARE[a]	1.207	(1.017-1.433)

[b] SD = standard deviation.
[a] Bare = bare ground, rock, and biological soil crusts.

While not a true sagebrush obligate species, Loggerhead Shrikes are a species of great concern in western shrubsteppe landscapes. Of most importance to this species is likely the presence of shrub height diversity. Loggerhead Shrikes were more likely to be present in shrub stands containing the greatest diversity in shrub heights, always selecting the tallest shrubs for nest placement, singing, territory defense, and plucking posts. As low- and mid-elevation shrubsteppe is burned and degraded, diversity in shrub heights decreases. Our results confirm that this species will also likely be a great challenge for land managers because of its association with older, more structurally diverse, and less disturbed shrub stands containing bare ground.

Lark Bunting

The Lark Bunting is not a shrubsteppe obligate songbird, but rather a grassland bird of the central plains (Shane 2000). This species is uncommon in Idaho, and because of its relative rarity in the state, we included details about habitat associations in this report. Analysis of BBS data indicate that this species has declined over much of its range, however, expansions are occurring in portions of the range such as Montana and Alberta (Peterjohn and Sauer 1999). It is suspected that a range expansion of this species is also occurring in Idaho, but it is unknown if this phenomenon is temporary, permanent, or related to weather patterns or other factors.

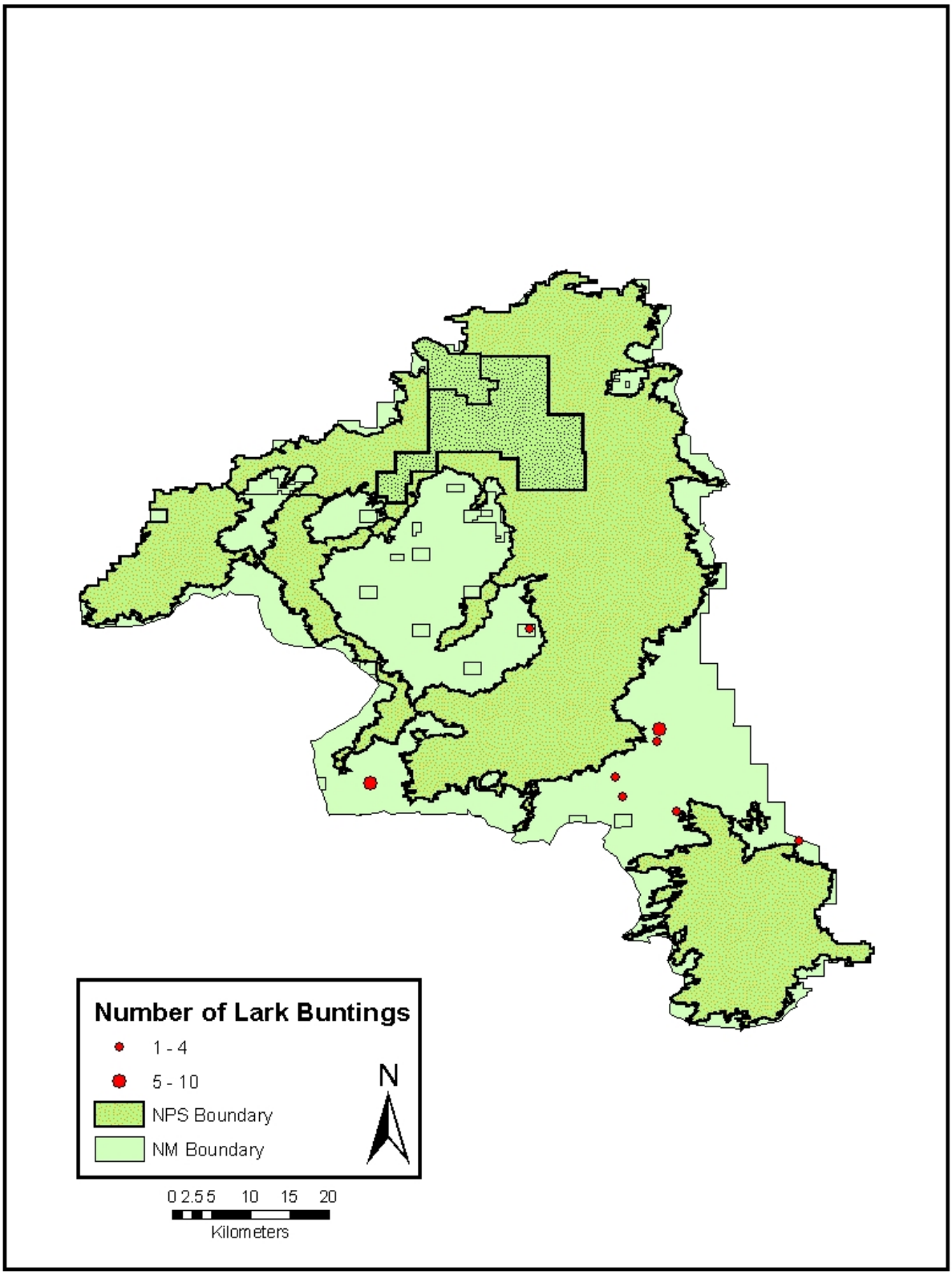
Lark Buntings were uncommon at Craters throughout this study, but they were not rare. They were present at 6 out of the 21 study sites and 8 out of 63 sampling plots (n = 31; Table 1). Lark Buntings were most abundant at sites C34 (n = 9) and sites C30 and L42 (both sites n = 8; Table 1; Fig. 13). Lark Buntings were present at plots where sagebrush cover ranged from 0.6% to 8.0% (mean = 2.97%), where forb cover ranged from 3.1% to 8.2% (mean = 5.43%), and where grass cover ranged from 4.4% to 12.3% (mean = 6.81%; Table 31).

Table 31. Summary of vegetation variables at plots where Lark Buntings were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Lark Bunting: Number of Plots Present = 8

Vegetation Parameter	Mean	SD	Minimum	Maximum
Elevation (m)	1488.41	109.46	1312.63	1661.50
% Shrub Cover	4.37	2.98	1.30	10.50
Shrub Height (in.)	24.67	7.80	14.90	38.30
% Sagebrush Cover	2.97	2.21	0.60	8.00
Sagebrush Height (in.)	28.13	7.94	15.60	42.00
Sagebrush Height Diversity Index (SD)	11.34	3.70	6.18	17.53
% Forb Cover	4.40	1.46	2.50	6.60
Forb Height (in.)	5.43	1.97	3.10	8.20
% Annual Forb Cover	3.11	1.01	1.80	4.83
Annual Forb Height (in.)	4.82	2.17	2.40	7.90
% Perennial Forb Cover	1.32	.97	0.30	3.33
Perennial Forb Height (in.)	6.70	3.21	2.40	11.10
% Grass Cover	17.27	2.85	13.80	23.20
Grass Height (in.)	6.81	2.47	4.40	12.30
% Annual Grass Cover	8.52	4.00	3.60	15.30
Annual Grass Height (in.)	5.30	.72	4.10	6.10
% Perennial Grass Cover	8.74	3.53	5.20	15.00
Perennial Grass Height (in.)	7.65	3.16	3.50	13.80
% Litter	3.14	.58	2.40	3.90
% BARE	10.91	2.10	7.83	13.33

Figure 13. Relative abundance and location of sampling plots where Lark Buntings were present, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.



At Craters, Lark Buntings were positively associated with bare ground, grass cover, litter, and forb height, although sample sizes were small (Table 32). For every one percent increase in bare ground, grass cover, and litter, and for every one-inch increase in mean forb height, the odds that Lark Buntings were present at a site increased by 10.7%, 11.26%, 7.83%, and 21.64%, respectively.

Table 32. Results from logistic regression analysis for Lark Bunting, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Lark Bunting: Logistic Regression Results

Vegetation Parameter	Estimate	*P*-value	Odds Ratio	Model χ^2	Model *P*-value
% BARE	0.1017	0.0071	1.1070	26.56, df = 4	≤0.0001
% Grass	0.1067	0.0001	1.1126		
% Litter	0.0754	0.1035	1.0783		
Forb height	0.1959	0.0048	1.2164		

[a] BARE = bare ground, rock, and biological soil crusts.

We also found Lark Buntings elsewhere within the Shoshone BLM District, but we did not find Lark Buntings anywhere else in southwestern or south central Idaho. Habitat associations for Lark Buntings at Craters were roughly similar to results from these other areas (Table 33). Overall, Lark Buntings were negatively associated with sagebrush cover, and positively associated with sagebrush height diversity and the mean height of annual forbs. For every one percent increase in sagebrush cover, the odds that Lark Buntings would be present at a site decreased by 15.6%. For every one-unit increase in sagebrush height diversity and for every one-inch increase in mean forb height, the odds that Lark Buntings were present increased by 13.6% and 18.7%, respectively.

As expected, Lark Buntings were not associated with sagebrush or other shrubs, but instead, grass cover, forb height, bare ground, and litter were the best predictors of presence. These data are interesting and show evidence for a possible range expansion in Idaho, however, this species is not a major concern within the shrubsteppe biome.

Table 33. Results from logistic regression analysis for Lark Bunting, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Lark Bunting Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
% Sage	0.844	(0.721-0.987)
Sage SD[b]	1.136	(1.013-1.273)
Annual Forb Height	1.187	(1.004-1.403)

Gray Flycatcher

The Gray Flycatcher is associated with shrubsteppe, mountain mohagony, and pinyon juniper habitats of western North America (Sterling 1999). This species is not widespread, and habitat characteristics associated with Gray Flycatcher abundance are not well known. In shrubsteppe, they are associated with tall sagebrush (Sterling 1999). A recent analysis of BBS data reveals

that Gray Flycatcher populations have increased significantly over the long-term (1968-2001) in the Western BBS region. No population trends are evident in routes within the Columbia Plateau.

Gray Flycatchers were not commonly detected at Craters sites. Craters lies within the extreme northeastern portion of the species' range. Gray Flycatchers were present at only 3 out of the 21 study sites and 4 of the 63 sampling plots (n = 5; Table 1). Due to this small sample size, we do not present habitat results at Craters sites for this species. However, Gray Flycatchers were abundant in other areas sampled within southwestern Idaho during 2002-2004, and they were especially abundant in subregions sampled within the Owyhee uplands. In these areas, Gray Flycatchers were positively associated with sagebrush cover and sagebrush height diversity. As sagebrush cover and the diversity of sagebrush heights both increased, Gray Flycatchers were more likely to be found at a site. Specifically, for every one-percent increase in sagebrush cover, and for every one-unit increase in sagebrush height diversity, Gray Flycatchers were 18.9% and 17.3% more likely to be present at a site (Table 34). Our data suggest that Gray Flycatchers prefer dense sagebrush stands with greater height diversity. Indeed, it was apparent during this study that this species preferred sagebrush stands containing at least some taller basin big sagebrush (*A.t. tridentata*) for nest placement and singing/territorial perches.

Table 34. Results from logistic regression analysis for Gray Flycatcher, statewide survey, Spring 2002-2004; Idaho Bird Observatory.

Gray Flycatcher Logistic Regression Results: Statewide

Vegetation Parameter	Odds Ratio	(Confidence Interval)
% Sage	1.189	(1.025-1.379)
Sage SD[b]	1.173	(1.078-1.277)

Analysis of Regional Vegetation Attributes

Results from the principal components analysis of regional vegetation attributes showed that vegetation differed significantly among subregions in southwestern and south central Idaho at our study sites. The principle components analysis returned six distinct vegetation factors which explained 75.1% of the total variation among the 22 habitat variables collected; factor loadings are presented below in Table 35. Distinct vegetation factors included *Forb Height*, *Shrub Height*, *Grass Cover*, *Forb Cover*, *Shrub Cover*, and *Grass Height* and are described below in Table 36.

Table 35. Factor loadings of distinct vegetation factors resulting from principal components analysis. Rotated (Varimax) Factor Pattern, all vegetation variables[1].

Variable	*Forb Height*	*Shrub Height*	*Grass Cover*	*Forb Cover*	*Shrub Cover*	*Grass Height*
Mean forb height	88	0	14	17	2	15
Mean annual forb height	77	2	3	1	-3	5
Mean perennial forb height	70	8	16	31	3	24
Mean annual grass height	60	15	0	-2	6	31
Mean shrub height	1	91	8	9	5	5
Mean sagebrush height	19	79	1	4	5	7
Height index	-6	74	15	16	9	11
Percent annual grass	37	57	-6	-11	-46	-29
Percent perennial grass	7	2	91	14	5	21
Percent grass	33	40	77	4	-27	-1
Percent bare	-48	36	-51	-40	-4	-7
Percent litter	0	3	-52	-38	5	7
Percent forb	19	12	23	92	5	8
Percent perennial forb	25	-9	39	73	24	-2
Percent annual forb	-1	38	-11	67	-27	15
Percent shrub	10	15	-6	8	91	-6
Percent sagebrush	0	8	-9	-5	89	-19
Mean elevation	-3	-31	42	-6	47	14
Mean grass height	37	4	17	7	-5	87
Mean perennial grass height	27	13	2	7	-16	85
% of variation explained	*28.2*	*13.1*	*11.5*	*9.5*	*6.5*	*6.3*

[1]Factor loadings multiplied by 100 for easier reading; those over 40 are shaded. Total variance explained: 75.1%.

Table 36. Factor names and descriptions from principal components analysis of regional vegetation attributes.

Factor	Name	Description
1	*Forb Height*	Scores of the *Forb Height* factor are highest for those sites where annual, perennial and total forb heights are highest, where annual grasse heights are highest, and where bare ground is minimal.
2	*Shrub Height*	Scores of the *Shrub Height* factor are highest for those sites where mean shrub heights and mean sagebrush heights are high, yet also where there is large variability in shrub heights. High annual grass cover and general grass cover also contribute to high scores on this factor.
3	*Grass Cover*	Scores of the *Grass Cover* factor are highest when perennial and total grass cover is high, and when the percent cover of bare ground and litter are low. To an extent, higher elevation also raises the scores on this factor.
4	*Forb Cover*	Scores of the *Forb Cover* factor are highest when perennial, annual, and total forb cover are high.
5	*Shrub Cover*	Scores of the *Shrub Cover* factor are highest when sagebrush and general shrub cover are high. To an extent, annual grass cover is negatively associated with this factor.
6	*Grass Height*	Scores of the *Grass Height* factor are highest when perennial and general grass cover are high.

Based on the strong results of the principal components analysis, a one-way analysis of variance was run for each of the six factors. Region displayed significant differences for all six factors, and means and standard deviations of vegetation variables by subregion are presented below in Table 37.

Results from pairwise significance testing for each of the six factors by subregion are shown below in Figure 14. With regard to *Forb Heights*, sites sampled at Craters sites were moderate, and most similar to sites sampled at Hixon, Murphy, Riddle, Triangle, Jarbidge, Burley, and Cassia (Figure 14). A general pattern was that the *Forb Height* scores decreased with elevation at sample sites. The highest-elevation sites contained the lowest *Forb Height* scores, and included Sawtooth Valley, Copper Basin, Pahsimeroi Valley, Lemhi Valley, and Sheep Creek (Figure 14). Sites sampled at Craters were also moderate with regard to *Shrub Height* scores, and were most similar to sites sampled at Murphy, Copper Basin, Cassia, and Hixon. Sites sampled within the Sawtooth Valley had the highest *Shrub Height* score, while those in Lemhi Valley, Glenns Ferry, Pahsimeroi Valley, Riddle, and Jarbidge had the lowest *Shrub Height* scores. Sites sampled at Craters were also moderate with regard to *Grass Cover* scores, and were similar to sites sampled at Copper Basin, Pahsimeroi Valley, and Riddle. The highest *Grass Cover* scores were found at Hixon, while the lowest were found at Glenns Ferry and Sheep Creek. Sites at Craters were high with regard to *Forb Cover* scores, and were similar to sites sampled at Burley and Cassia. Only sites at Shoshone and Hixon had higher *Forb Cover* scores, while Glenns Ferry sites had the lowest *Forb Cover* scores. *Shrub Cover* scores were lowest at Craters sites, and were similar to those from sites sampled at Hixon, Glenns Ferry, Triangle, Sheep Creek, and Murphy. The highest *Shrub Cover* scores were found at sites in the Lemhi

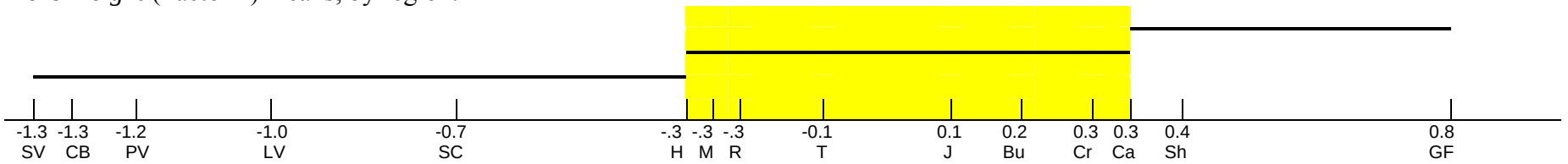
Valley and Copper Basin. Craters sites were among the highest with regard to *Grass Height* scores. Only Cassia study sites had higher *Grass Height* scores. Sites at Hixon, Pahsimeroi Valley, and Glenns Ferry had the lowest *Grass Height* scores.

Table 37. Means and standard errors (in parentheses) of vegetation factors by subregion.

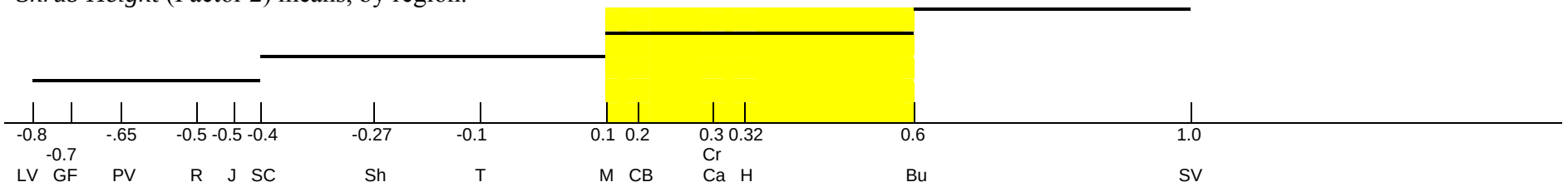
	Region	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
CB	Copper Basin	-1.290	0.150	-0.426	-0.810	1.365	-0.096
		(0.15)	(0.13)	(0.18)	(0.16)	(0.12)	(0.23)
LV	Lemhi Valey	-0.99	-0.79	0.68	-0.34	0.651	-0.762
		(0.18)	(0.18)	(0.39)	(0.15)	(0.18)	(0.13)
PV	Pahsimeroi Valley	-1.2	-0.652	-0.379	-0.531	0.592	-1.05
		(0.15)	(0.20)	(0.06)	(0.04)	(0.12)	(0.15)
SV	Sawtooth Valley	-1.35	1.022	0.023	-0.979	0.579	-0.584
		(0.42)	(0.15)	(0.39)	(0.15)	(0.41)	(0.08)
Cr	Craters	0.288	0.269	-0.351	0.309	-0.521	0.457
		(0.13)	(0.10)	(0.08)	(0.10)	(0.13)	(0.15)
Bu	Burley	0.176	0.584	0.875	0.298	0.265	-0.229
		(0.207)	(0.333)	(0.203)	(0.281)	(0.247)	(0.177)
Ca	Cassia	0.347	0.270	0.782	0.120	0.605	0.900
		(0.51)	(0.07)	(0.40)	(0.23)	(0.32)	(0.22)
J	Jarbidge	0.065	-0.473	1.025	-0.374	-0.004	-0.265
		(0.20)	(0.24)	(0.15)	(0.15)	(0.20)	(0.14)
Sh	Shoshone	0.423	-0.268	0.307	1.113	0.467	-0.045
		(0.16)	(0.14)	(0.15)	(0.24)	(0.20)	(0.20)
GF	Glenns Ferry	0.841	-0.731	-1.220	-1.110	-0.478	-0.861
		(0.49)	(0.33)	(0.12)	(0.07)	(0.34)	(0.40)
M	Murphy	-0.303	0.102	-0.559	-0.382	-0.014	-0.125
		(0.23)	(0.28)	(0.29)	(0.16)	(0.23)	(0.20)
R	Riddle	-0.271	-0.535	-0.319	-0.801	0.321	-0.205
		(0.15)	(0.22)	(0.19)	(0.09)	(0.14)	(0.22)
SC	Sheep Creek	-0.7	-0.445	-0.951	-0.948	-0.026	0.79
		(0.16)	(0.25)	(0.27)	(0.14)	(0.74)	(0.81)
T	Triangle	-0.137	-0.095	-0.5	-0.459	-0.05	0.057
		(0.13)	(0.18)	(0.22)	(0.11)	(0.13)	(0.17)
H	Hixon	-0.340	0.318	1.060	2.543	-0.595	-1.070
		(0.35)	(0.24)	(0.09)	(0.65)	(0.21)	(0.08)

Figure 14. Vegetation factor means by region. Horizontal lines covering regions indicate these regions are not significantly different from each other at p≤0.05.

Forb Height (Factor 1) means, by region.



Shrub Height (Factor 2) means, by region.



Grass Cover (Factor 3) means, by region. Horizontal lines covering regions indicate these regions are not significantly different from each other at p≤0.05.

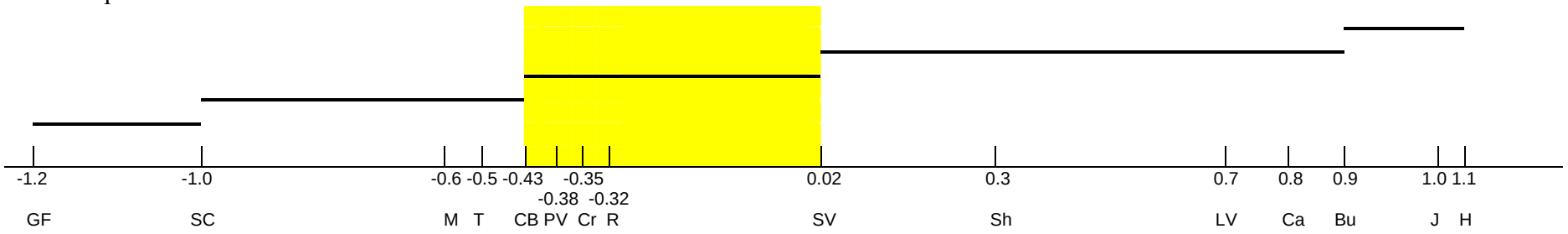
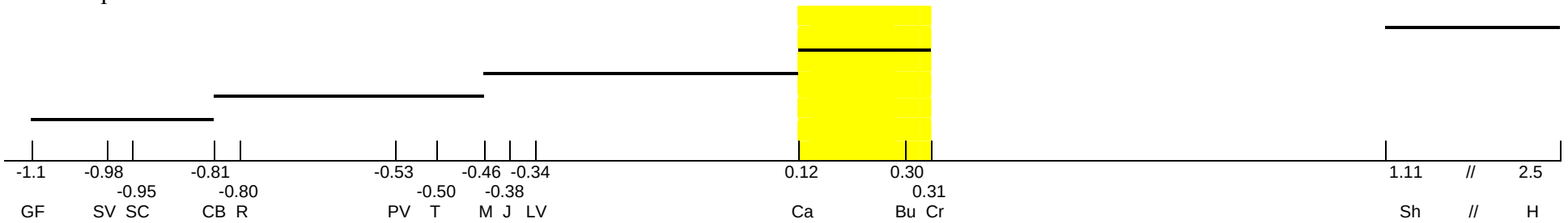
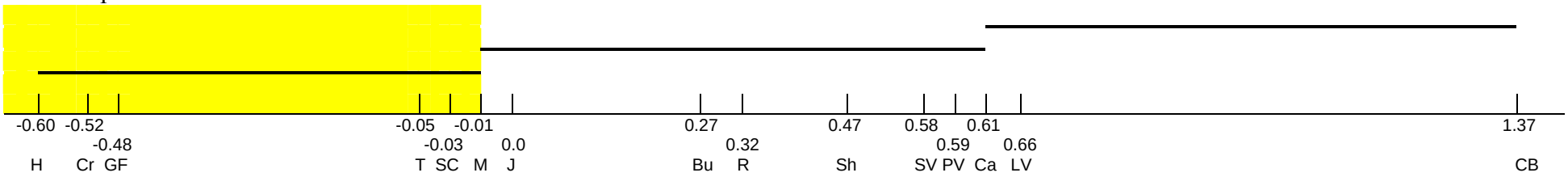


Figure 14, Continued.

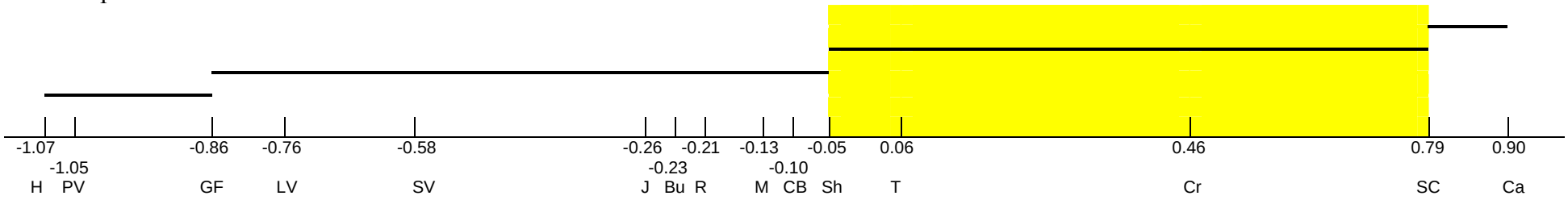
Forb Cover (Factor 4) means, by region. Horizontal lines covering regions indicate these regions are not significantly different from each other at p≤0.05.



Shrub Cover (Factor 5) means, by region. Horizontal lines covering regions indicate these regions are not significantly different from each other at p≤0.05.



Grass Height (Factor 6) means, by region. Horizontal lines covering regions indicate these regions are not significantly different from each other at p≤0.05.



Greater Sage-Grouse Preferred Forb Evaluations

A summary of the *Site Preferred Forb Abundance and Diversity Forms for Sage-Grouse Evaluations* (U.S. Department of the Interior 2000; Appendix B) recorded at each plot revealed that approximately 50% of the 63 plots sampled contained habitat that was suitable for Greater Sage-Grouse based on the presence of preferred forbs alone (Table 38; Appendix D). Only 3 plots contained habitat considered to be "unsuitable" for Sage-Grouse, while 28 plots contained "marginal" habitat. At 12 plots we observed either Greater Sage-Grouse or their sign, which mainly included pellets.

Table 38. Suitability of habitat at plots sampled for passerine birds based on preferred forbs, and number of plots where Greater Sage-Grouse or sign was observed.

Sage-Grouse Suitability	Number of Plots
Unsuitable	3
Marginal	28
Suitable	32
Total Number of Plots	63
Sage-Grouse (or sign) Observed	12

Discussion

Sagebrush-dominated steppe occurs across 11 Western states, and historically was one of the most extensive habitat types in North America. Currently, sagebrush steppe is one of North America's most threatened ecosystems (Mac et al. 1998). The process of recurring wildfires and invasion of exotic annual grasses has created a highly fragmented landscape, fast traveling on a trajectory from native shrubland to exotic grassland (Knick and Rotenberry 1997, 2002). These highly disturbed and fragmented areas of native shrubsteppe significantly influence the presence of shrubsteppe-obligate bird species such as Brewer's Sparrow, Sage Sparrow, and Sage Thrasher, favoring more grassland or generalist species such as Western Meadowlark and Horned Lark as shrub cover decreases and grassland increases (Knick and Rotenberry 1995, 2002; Rotenberry and Knick 1999). In southwestern Idaho, a spatial analysis revealed that the distribution of breeding shrubsteppe birds was related to the distribution of large shrub patches on a landscape level (Knick and Rotenberry 1999).

A recent analysis and summary of issues within shrubsteppe habitat in the Intermountain West does not offer much optimism for the future of this biome (Dobkin and Sauder 2004). This report examined BBS results for 25 upland birds that depend on or are found in shrubsteppe ecosystems, and reports that 10 of these species have exhibited long-term (1968-2001) population declines, and 13 species have shown short-term (1984-2001) declines (Dobkin and Sauder 2004). Of these 25 species, 11 were commonly detected at Craters during this study (including Greater Sage-Grouse), and of those, eight currently have federal or state special conservation status either throughout or within portions of the shrubsteppe biome (Table 39). Of these 11 species commonly detected at Craters, four are exclusive sagebrush steppe obligates which rely on sagebrush for nesting, foraging, and/or brood-rearing habitat, and include Greater Sage-Grouse, Brewer's Sparrow, Sage Thrasher, and Sage Sparrow. Of these species, Brewer's Sparrow and Sage Sparrow have federal conservation status. In addition, the Loggerhead Shrike has both Federal and state conservation status in the state of Idaho (Table 39).

Table 39. Current conservation status of the 10 most-commonly detected shrubsteppe birds (also includes Greater Sage-Grouse and Gray Flycatcher) at Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory.

Species	Federal Special Status	State Special Status
Greater Sage-Grouse	Petitioned for Listing, but Official Finding that Listing not Warranted	Oregon, Nevada, Utah: Species of concern Washington: Threatened
Horned Lark	None	Oregon: Species of Concern
Western Meadowlark	None	None
Brewer's Sparrow	USFWS, USDI BLM (Idaho and Nevada): Species of Concern	None
Sage Thrasher	USDI BLM (Wyoming): Species of Concern	Washington: Species of Concern
Lark Sparrow	None	None
Vesper Sparrow	USDI BLM (Nevada): Species of Concern	Oregon: Species of Concern
Grasshopper Sparrow	USDI BLM (Utah): Species of Concern	Oregon, Utah, Wyoming: Species of Concern
Sage Sparrow	USFWS, USDI BLM (Idaho, Oregon, Wyoming): Species of Concern	Oregon, Washington: Species of Concern
Loggerhead Shrike	USFWS, USDA FS, USDI BLM (Idaho, Nevada, Wyoming): Species of Concern	Idaho, Oregon: Species of Concern Washington: Candidate for Listing
Lark Bunting	None	None
Gray Flycatcher[1]	USDA FS, Pacific Region: Species of Concern	None

[1]Not commonly detected at Craters, but included for comparison

Craters of the Moon National Monument and Preserve consists primarily of recently-exposed lava formations of the Great Rift, but as the result of a recent boundary expansion, also contains considerable shrubsteppe habitat which occurs along both elevational gradients and gradients of varying habitat condition. Craters is located within the Columbia Plateau Ecoregion (Nature Conservancy 2001), and is generally contained within a relative stronghold of sagebrush-dominated landscape in south central Idaho (Knick et al. 2003). Overall, less than 3% of sagebrush-dominated shrubsteppe throughout the sagebrush biome occurs within national parks or wilderness areas that are permanently protected from land-cover conversion (Scott et al. 2001).

In general, we found shrubsteppe habitat where we sampled at Craters to be representative of habitats sampled throughout southwestern and south central Idaho. Craters was similar to other subregions where we sampled with regard to grass cover, but had lower shrub cover, higher forb cover, forb height, and shrub height, and significantly greater grass height than sites sampled within other areas. We suggest that these differences in vegetation attributes, in part, influenced the presence and abundance of shrubsteppe birds at our sample locations.

We detected roughly the same proportion of Brewer's Sparrows, Sage Sparrows, and Sage Thrashers at Craters sites as we did elsewhere in southern Idaho. These three shrubsteppe-obligate species are all closely tied to the distribution and extent of sagebrush, indicating that sagebrush habitat at Craters is comparable to other areas sampled in southern Idaho. In addition, we detected comparatively more Loggerhead Shrikes at Craters than within other subregions, possibly pointing to the importance of shrub heights, and especially shrub height diversity, to this species. Sage Thrashers also were associated with greater shrub height diversity, and this variable contributed to the greater *Shrub Height* score identified at Craters sites than elsewhere within the study area (Figure 14). Thus, one way in which Craters sites differed from other sites within the study area was by having taller and more structurally diverse sagebrush stands, likely contributing to the presence and abundance of these shrubsteppe-obligate passerines. While it is

encouraging to note the greater abundance of these sagebrush obligates at Craters, Knick and Rotenberry (2000) caution that while current habitat associations may be the most important factor affecting shrubsteppe bird communities, because of philopatry and high site-fidelity, presence and abundance of shrubsteppe obligates may lag behind major habitat changes or degradation.

Sites sampled at Craters also contained significantly greater grass and forb components, both forb height and forb cover, than other sites sampled throughout southern Idaho (Figure 14). This illustrates that Craters sagebrush steppe, while it still may provide adequate habitat for many shrubsteppe obligates, has been highly degraded by the influences of fire, grazing, and invasion of exotic annual grasses and forbs. The widespread presence of these grass and forb factors likely contributed to the high proportion of the more grassland or generalist songbird species detected during this study. We detected Horned Larks and Western Meadowlarks at every Craters site during this study. Horned Larks were associated with a decrease in all shrub variables, including shrub cover and the structural diversity of shrubs. Western Meadowlarks were closely associated with grass/forb habitat components, including increasing cover of grasses, forbs, and litter. Grasshopper Sparrows were also more common at Craters sites than other sites sampled in southern Idaho, and were closely associated with grass cover and height, indicating that this habitat component at Craters sites was well established and dominant in many areas. Lark Sparrows also were more common at Craters sites, and were closely associated with decreased shrub cover, but increased shrub height and structural diversity. This species typically is found in more degraded habitats where structural diversity is present, and at Craters, we found Lark Sparrows to be most closely associated with the edges of lava flows. Lark Bunting, another grassland species, was also more common at Craters sites, and was associated with bare ground, grasses, litter, and forbs. Curiously, Vesper Sparrows were less common at Craters sites than elsewhere in southern Idaho, but we found that elevation coupled with grasses was the most important factor influencing presence of this species. For Vesper Sparrows, this possibly points to the importance of native bunch grasses, which typically increase in density with elevation, to this species.

Because we detected more of the grassland or generalist species at Craters sites, it might be easy to assume that as habitat degradation within the shrubsteppe biome continues, and conversion to exotic grassland becomes more complete, populations of these bird species should increase throughout the region as shrubstepe obligates decline. However, population trajectories for all or most of these species, both sagebrush obligates and grassland species, are in decline throughout the shrubsteppe biome (Dobkin and Sauder 2004). For the most part, what is largely unknown is the ability of landscapes dominated by annual grasses such as cheatgrass to meet the habitat requirements of these grassland species, all of which evolved within communities dominated by or containing native bunch grasses (Dobkin and Sauder 2004). We found many Craters sites to be highly degraded by exotic annual grasses and forbs. As expected, these exotics were present along an elevational gradient, as lower elevation sites in the southern areas of the Monument were more degraded by fire, grazing, and other influences. However, all sites sampled contained some exotic annual grasses and forbs. We found southern sites within the Monument to be among some of the most highly-degraded sites sampled within southern Idaho, and understories were dominated by cheatgrass and annual forbs, namely tumble mustards.
This was not a study of Greater Sage-Grouse or Sage-Grouse habitat, but rather a study of habitat associations of other shrubsteppe birds. However, identifying habitat associations of shrubsteppe-dependent songbirds has implications for management of Sage-Grouse, since the

majority of management actions currently implemented in shrubsteppe are designed to maintain adequate habitat and viable populations of Sage-Grouse. Greater Sage-Grouse have been considered a good "umbrella" species for management of other shrubsteppe-dependent birds and mammals, and it has been assumed that successful management for this species will benefit other shrubsteppe obligates. We found that the majority of sites sampled for shrubsteppe passerines at Craters were either suitable or marginal for Greater Sage-Grouse based on the presence of preferred forbs alone, however we recorded Sage-Grouse or their sign at only 12 sites (Table 38). According to Connelly et al. (2000), Greater Sage-Grouse breeding areas need to have sagebrush cover from 15% - 25% with heights 40 - 80 cm (16-32 in.), and herbaceous plants should be at least 18 cm (7 in.) tall and have >15% cover. At approximately 50% of individual points where vegetation was sampled at Craters during this study, sagebrush cover was >15% and sagebrush heights were within the range of 40 - 80 cm (Table 40). At the majority of points sampled, herbaceous cover was well within the guidelines recommended for Sage-Grouse by Connelly et al. (2000). Therefore, based on sites sampled during this study, Craters is likely a relatively "good" example of remaining habitat for Greater Sage-Grouse (given the widespread loss and degradation of shrubsteppe habitat rangewide). Craters lies well within the current distribution of the species (Schroeder et al. 2004) and provides a critical link between higher-elevation nesting and brood-rearing habitat and lower-elevation wintering habitat.

We examined the Greater Sage-Grouse management guidelines in relation to other bird species commonly found in Idaho's shrubsteppe regions. We used habitat associations identified for these other species during this study and compared them to the guidelines suggested by Connelly et al. (2000). We used logistic regression and set the model to a specified set of predictor variables to reflect the recommended guidelines for Sage-Grouse: sagebrush height and cover were set at 60 cm (24") and 15%, respectively, while herbaceous height and cover were set at 18 cm (7") and 15%, respectively. We calculated probabilities of occurrence of other bird species based on this specified set of predictor variables, and found that the probability of occurrence of Brewer's Sparrows, Vesper Sparrows, Sage Thrashers, and Western Meadowlarks would be 98%, 83.8%, 83.5%, and 80.9%, respectively, under this set of habitat conditions (Idaho Bird Observatory, unpublished data). Furthermore, under this set of habitat conditions, our data indicate that the probability of occurrence of Sage Sparrows, Gray Flycatchers, Horned Larks, Lark Sparrows, Loggerhead Shrikes, Grasshopper Sparrows, and Lark Buntings would be 51.5%, 38.7%, 34.3%, 26.2%, 17.9%, 0.6% and 3.0%, respectively (Idaho Bird Observatory unpublished data). Thus, Greater Sage-Grouse may be an adequate "umbrella" species for management of habitat for other shrubsteppe birds, as both Brewer's Sparrows and Sage Thrashers (both shrubsteppe obligates) would be present under the set of habitat conditions required by nesting Sage-Grouse. However, Sage Sparrows, Gray Flycatchers, and Loggerhead Shrikes (all important shrubsteppe species) would be less likely to occur under these habitat conditions, illustrating the limitations of these recommended guidelines for management of all shrubsteppe-dependent bird species.

Finally, we were not able to adequately address the final objective of this study to "assess the relative value of fragmented islands of shrubsteppe habitat (kipukas, vegetated lava) for shrubsteppe bird species" with our results. While many of the potential study sites identified as a result of the GIS random site selection were located in these habitats, most did not contain large enough blocks of contiguous habitat for establishment of study plots consistent with this statewide effort. However, we summarized vegetation parameters by sampling point, calculating the mean and standard deviations (SD) for each vegetation variable, and present these values by

habitat cover type based on habitat classifications provided by the NPS. Habitat cover types included *Annual Grassland*, *Perennial Grassland, Low-elevation Sagebrush, Mid-elevation Sagebrush,* and *Vegetated Lava* (Table 40). The majority of our study sites were located within *Perennial Grasslands* and *Low-elevation Sagebrush*, and we further summarized vegetation parameters within these cover types by our GOOD, MODERATE, and POOR study plot designations. These summary statistics will provide NPS managers with vegetation structural data by habitat cover type. Summary data can be directly related to results from logistic regression analyses which identify vegetation variables associated with changes in the probability of occurrence of shrubsteppe bird species at Craters of the Moon National Monument.

Sites sampled in habitat classified as *Vegetated Lava* generally had lower shrub cover and height values, greater forb cover, lower grass cover, lower litter values, and significantly greater coverage of bare ground than the majority of sites sampled within the other habitat classifications at Craters (Table 40). Using habitat associations for shrubsteppe birds identified in this study, we would not expect *Vegetated Lava* habitats to be overly important to shrubsteppe-obligate birds. However, because shrub cover and height, and especially sagebrush cover and height, were lower in *Vegetated Lava* we would expect this habitat type to be associated with more of the grassland or generalist species such as Horned Lark, Western Meadowlark, and Lark Sparrow. In addition, specialist species such as Rock Wren (*Salpinctes obsoletus*) should also be common in these habitats. Rock Wrens were common at Craters (n = 27; Table 2), and were present at 9 out of 21 sites sampled.

The influence of fragmentation and patch size on shrubsteppe passerine birds is well-understood, and increasing fragmentation and decreasing patch size negatively influence shrubsteppe bird communities (Knick et al. 2003, Knick and Rotenberry 2002, Rotenberry and Knick 1999, Knick and Rotenberry 1997). Thus, since *Vegetated Lava* habitats are generally isolated and fragmented throughout the National Monument, and because of their habitat attributes, their overall utility to shrubsteppe-obligate birds is likely limited. Similarly, while kipukas may be valuable to offer insight into historic pre-disturbance vegetation communities, these habitats are also highly isolated. Though they may contain pristine examples of undisturbed native shrubsteppe vegetation, together they make up only a small percentage of the total acreage of the National Monument. Over the long-term, restoration and conservation of large contiguous blocks of native shrubsteppe vegetation at Craters would benefit the greatest number of shrubsteppe-obligate songbirds.

Table 40. Means and standard deviations (SD) of vegetation variables summarized by sampling point and habitat type, Craters of the Moon National Monument, Spring 2004; Idaho Bird Observatory. Cover values are percent cover and heights are in inches.

Habitat Type	# of Sampling Points[a]	Other Shrub Cover (SD)	Other Shrub Height	Sagebrush Cover (SD)	Sagebrush Height (SD)	Forb Cover (SD)	Forb Height (SD)	Grass Cover (SD)	Grass Height (SD)	% Litter (SD)	% BARE[b] (SD)
Annual Grassland	25	4.72 (4.83)	14.38 (11.88)	12.40 (14.60)	23.45 (17.26)	11.28 (9.59)	3.67 (3.01)	46.08 (18.10)	7.42 (3.04)	10.56 (7.32)	33.92 (10.53)
Perennial Grassland (POOR)	43	5.72 (5.58)	9.90 (7.10)	3.02 (5.35)	11.64 (13.18)	17.58 (13.95)	4.52 (2.84)	44.56 (14.98)	9.39 (4.24)	9.26 (5.76)	33.44 (11.78)
Perennial Grassland, (MODERATE)	45	6.18 (4.90)	11.52 (6.42)	7.64 (7.20)	20.94 (12.00)	17.69 (13.50)	5.84 (3.75)	43.38 (15.19)	8.28 (3.68)	10.18 (5.89)	34.36 (9.61)
Perennial Grassland (GOOD)	22	2.73 (2.66)	7.52 (6.79)	11.46 (12.74)	19.52 (14.92)	14.91 (16.60)	5.07 (4.12)	44.18 (19.32)	5.81 (3.00)	7.36 (6.06)	28.55 (12.82)
Low-elevation Sage (POOR)	106	4.77 (5.65)	10.18 (8.78)	10.98 (11.49)	19.55 (14.36)	17.49 (10.62)	4.92 (2.83)	38.96 (15.12)	7.30 (3.55)	9.70 (8.61)	35.17 (12.15)
Low-elevation Sage (MODERATE)	108	4.04 (4.81)	12.57 (10.62)	18.69 (13.39)	23.42 (10.42)	13.28 (8.96)	5.21 (2.77)	40.39 (16.16)	6.67 (2.86)	8.39 (4.98)	35.22 (9.94)
Low-elevation Sage (GOOD)	122	6.51 (6.23)	17.01 (10.75)	22.00 (10.62)	30.40 (10.02)	17.48 (11.78)	5.38 (3.14)	42.46 (15.52)	6.34 (2.77)	9.74 (6.17)	30.05 (12.00)
Mid-elevation Sage	11	16.55 (4.82)	22.19 (4.92)	29.82 (8.78)	25.59 (3.96)	18.55 (6.99)	7.15 (1.51)	16.91 (6.02)	11.02 (3.58)	12.55 (4.57)	29.46 (7.80)
Vegetated Lava	17	3.18 (5.34)	8.12 (10.87)	7.29 (11.68)	12.08 (13.42)	20.47 (10.60)	4.57 (1.99)	22.12 (17.68)	9.42 (4.30)	6.47 (6.58)	50.47 (20.28)

[a] Points were classified using NPS habitat cover type classification. Two points were unclassified.
[b] BARE = bare ground, rock, and biological soil crusts.

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Appendix A. Standard American Ornithologist's Union (AOU) codes for bird species names.

Species Name	AOU Species Code
Bank Swallow	BANS
Blue-gray Gnatcatcher	BGGN
Brown-headed Cowbird	BHCO
Brewer's Blackbird	BRBL
Brewer's Sparrow	BRSP
Black-throated Sparrow	BTSP
Canada Goose	CAGO
Chipping Sparrow	CHSP
Clark's Nutcracker	CLNU
Cliff Swallow	CLSW
Common Nighthawk	CONI
Common Raven	CORA
Eastern Kingbird	EAKI
Ferruginous Hawk	FEHA
Gray Flycatcher	GRFL
Grasshopper Sparrow	GRSP
Horned Lark	HOLA
Killdeer	KILL
Lark Bunting	LARB
Lark Sparrow	LASP
Long-billed Curlew	LBCU
Loggerhead Shrike	LOSH
Mourning Dove	MODO
Northern Flicker	NOFL
Northern Harrier	NOHA
Prairie Falcon	PRFA
Rock Wren	ROWR
Red-winged Blackbird	RWBL
Sage Grouse	SAGR
Say's Phoebe	SAPH
Sage Sparrow	SASP
Sage Thrasher	SATH
Tree Swallow	TRSW
Vesper Sparrow	VESP
Violet-Green Swallow	VGSW
Western Kingbird	WEKI
Western Meadowlark	WEME

Appendix B-1. Point count field data form

IBO Sagebrush Steppe Point Count Data Form 2002 pg.___ of___

State ____ Region ____ Station # ____ Month ____ Day ____ Year ____ Visit # ____

First Name ____ Last Name ____

point	time	species	0-25	25-50	50-75	75-100	>100	flyover	b. obs

Breeding Obs. Codes: C = Copulation; M = Material Carry; FC = Food Carry; N = Nest Found; FL = Fledgling; FS = Fecal Sac Carry; DD = Distraction Display

S = Singing, V = Visual, C = Calling

Weather Information: Please estimate temperature, cloud cover (% of sky covered by clouds), and appropriate wind speed.

_____ °F or °C (circle one) Temperature _____ % Cloud Cover _____ mph Wind Speed Entered_____ Proofed_____

Appendix B-2. Vegetation assessment field data form.

Line Point Transect Data Form for Sage Grouse Evaluations (see directions provided) (5/23/01)

Date:	Project or Allotment Name/#:		
Pasture Name/ #:	Site#:	FO:	GPS File:
Legal Description: T. R. Section , 1/4, 1/4		UTM #:	
Cover Type:	Ecological Site:	Tape or Pace Transect? (circle one)	
Examiner(s):	Location Info.:		

Points	Top Layer Hits		Lower Canopies				Points	Top Layer Hits		Lower Canopies			
			Layer 2 Hits		Layer 3 Hits					Layer 2 Hits		Layer 3 Hits	
	Species	Height	Species	Height	Species	Height		Species	Height	Species	Height	Species	Height
1							26						
2							27						
3							28						
4							29						
5							30						
6							31						
7							32						
8							33						
9							34						
10							35						
11							36						
12							37						
13							38						
14							39						
15							40						
16							41						
17							42						
18							43						
19							44						
20							45						
21							46						
22							47						
23							48						
24							49						
25							50						

DATA SUMMARIES FOR ASSESSMENT WORKSHEET (see directions)

Sagebrush Canopy Cover	Avg. Sagebrush Height	Avg. PG&PF Heights	PG Canopy Cover	Forb Canopy Cover
Hits_____, %_____			Hits_____, %_____	Hits_____, %_____

OPTIONAL DATA SUMMARIES (see directions)

Annual Grass Cover	Annual Forb Cover	Avg. Perennial Grass Height	Avg. Perennial Forb Height	Other Shrub Cover
Hits_____, %_____	Hits_____, %_____			Hits_____, %_____

Appendix B-3. Greater Sage-Grouse preferred forb field data form.

Site Preferred Forb Abundance and Diversity Form for Sage Grouse Evaluations (5/23/01)

Date:	Project or Allotment Name/#:	Ecological Site:
Pasture Name/ #:	Site#:	Examiner(s):
Legal Descript.: T. R. Section , 1/4, 1/4	GPS File#	UTM:

Sage Grouse Preferred Forbs:	None - Rare	Sparse	Common - Abundant
Broomrape (*Orobanche* spp.)			
Composites			
Daisies (*Erigeron* and *Aster* spp.)			
Dandelion, C.(*Taraxacum officinale*)			
Dandelion, Mt. (Agoseris spp.)			
Hawksbeard (*Crepis* spp.)			
Microsteris (*Microseris* spp.)			
Prickly lettuce (*Lactuca serriola*)			
Salsify (*Tragopogan dubius*)			
Desert-parsley (*Lomatium* and *Cymopterus*)			
Everlasting (*Antennaria* spp.)			
Groundsmoke (*Gayophytum* spp.)			
Knotweed (*Polygonum* spp.)			
Legumes (other than *Lupinus* spp.)			
Alfalfa (*Medicago* spp.)			
Bird's foot tre-foil (*Lotus* spp.)			
Clover (*Trifolium* spp.)			
Sweet clover (*Melilotus* spp.)			
Sweet vetch (*Hedysarum* spp.)			
Vetch (*Vicia* spp.)			
Milkvetch (*Astragalus* spp.)			
Peppergrass (*Lepidium* spp.)			
Phlox (*Phlox* spp.)			
Prairie star flower (*Lithophragura* spp.)			
Yarrow (*Achillea millifolium*)			
Other Forbs / Noxious Weeds:			
Comments on Abundance and Diversity:			

Site Summary (see directions)	Suitable	Marginal	Unsuitable
Circle One of the Following:	Forbs are common with at least a few preferred species present	Forbs are common but only 1 or 2 preferred species present	Forbs are rare to sparsely present

Appendix C. Beaufort Wind Scale

Force 0: < 1 km/hour; calm smoke rises vertically
Force 1: 1 – 5 km/hour; smoke drift shows wind direction
Force 2: 6 – 11 km/hour; leaves rustle, wind is felt on face
Force 3: 12 – 19 km/hour; leaves and small twigs in constant motion, light flag extended
Force 4: 20 – 28 km/hour; wind raises dust, leaves and loose paper, branches in motion
Force 5: 28 – 38 km/hour; small trees in leaf sway
Force 6: 39 – 49 km/hour; larger branches in motion, whistling heard in wires
Force 7: 50 – 61 km/hour; whole trees in motion, resistance felt walking against the wind

Appendix D. Vegetation Codes.

CODE	COMMON NAME	SCIENTIFIC (LATIN)	VEG CATEGORY	FAMILY
AF	Annual Forb		Annual Forb	
AGGL	False Dandelion	*Agoseris glauca*	Annual Forb	Compositae
BLSC	Blepharipappus	*Blepharipappus scaber*	Annual Forb	Compositae
CHLE	Chenopode	Chenopodiaceae leptophyllum	Annual Forb	Chenopodiaceae
COLL	Collumia Species	*Collomia grandiflora/linearis*	Annual Forb	Polemoniaceae (Phlox)
COPA	Blue-eyed Mary	*Collinsia parviflora*	Annual Forb	Scrophulariaceae
CRUC	Mustard		Annual Forb	Cruciferaceae
DRVE	Spring Whitlow Grass	*Diplotaxis muralis*	Annual Forb	Cruciferaceae
GYMN	Gymnosterous	Gymnosterous sp.	Annual Forb	
GYNU	Gymnosterous nudicaulis	Gymnosterous sp.	Annual Forb	
KOSC	Kochia	*Kochia scoparia*	Annual Forb	Chenopodiaceae
LACT	Lactuca	Lactuca sp.	Annual Forb	
LAGL	Tidy Tips	Layia glandulosa	Annual Forb	Compositae
LAOC	Lactuca occidentalis	Lactuca sp.	Annual Forb	
LASE	Prickly Lettuce	*Lactuca serriola*	Annual Forb	Compositae
LEPE	Peppergrass	*Lepidium perfoliatum*	Annual Forb	Cruciferaceae
MENT	Blazing Star	Mentzelia sp.	Annual Forb	Loasaceae
MINA	Dwarf Monkeyflower	Mimulus nanus	Annual Forb	Scrophulariaceae
RATE	Bur. Buttercup	*Ranunculus testiculatus*	Annual Forb	Ranunculaceae
SIAL	Tumble Mustard	*Sisymbrium altissimum*	Annual Forb	Cruciferaceae
TRDU	Salsify	*Tragopogon dubius*	Annual Forb	Compositae
AG	Unknown Annual Grass		Annual Grass	Gramineae
BRJA	Japanese Brome	*Bromus japonicus*	Annual Grass	Gramineae
BRTE	Cheatgrass	*Bromus tectorum*	Annual Grass	Gramineae
ASSC	Lava Aster	*Aster scopulorum*	Annual/Perennial Forb	Compositae
PLAN	Plantain	*Plantago*	Annual/Perennial Forb	Plantaginceaae
BG	Bare Ground		Bare	
ROAD	road		Bare	
CC	Cryptogammic Crust		Crust	
LITT	Litter		Litter	
AMCI		*Amsinckia*	Perenial Forb	Boraginacea
CARE	Sedge Sprecies	*Carex*	Perennial	Cyperaceae
JUNC	Rush Sprecies	*Juncus*	Perennial	Juncaceae
AGCR	Creasted Wheatgrass	*Agropyron cristatum*	Perennial Bunchgrass	Gramineae
AGDE	Wheatgrass	*Agropyron desertorum*	Perennial Bunchgrass	Gramineae
AGIN	Intermediate Wheatgrass	*Agropyron intermedium*	Perennial Bunchgrass	Gramineae
AGSP	Blue-bunch Wheatgrass 2003	*Agropyron spicatum*	Perennial Bunchgrass	Gramineae
ELCI	Great Basin Wild RYE	*Elymus (Taeniatherum)*	Perennial Bunchgrass	Gramineae
FEID	Idaho Fescue	*Festuca idahoensis*	Perennial Bunchgrass	Gramineae
HECO	Needle-and-thread	*Stipa comata*	Perennial Bunchgrass	Gramineae
KOMA	Prairie Junegrass	*Koeleria cristata*	Perennial Bunchgrass	Gramineae
ORHY	Indian Ricegrass	*Oryzopis hymenoides*	Perennial Bunchgrass	Gramineae
PG	Unknown Perrenial Grass		Perennial Bunchgrass	Gramineae

Appendix D, Continued.

POBU	Bulbous Bluegrass	*poa bulbosa*	Perennial Bunchgrass	Gramineae	
POSE	Sandberg's Bluegrass	*Poa secunda*	Perennial Bunchgrass	Gramineae	
PSSP	Blue-bunch Wheatgrass 2002	*Pseudoroegneria spicata*	Perennial Bunchgrass	Gramineae	
SIHY	Bottlebrush Squirreltail	*Sitanion hystrix*	Perennial Bunchgrass	Gramineae	
STOC	???	*Stipa occidentalis*	Perennial Bunchgrass	Gramineae	
STTH	Thrubers Needlegrass	*Stipa thurberiana*	Perennial Bunchgrass	Gramineae	
ACMI	Yarrow	*Achillea millefolium*	Perennial Forb	Compositae	
ALFA	Alfalfa	*Trifolium species*	Perennial Forb	Leguminosae	
ALLI	Onion	*Allium*	Perennial Forb	Liliaceae	
AMRE	Fiddleneck	*Amsinckia retrorsa*	Perennial Forb	Boraginacea	
AMSI	Amsinckia	*Amsinckia*	Perennial Forb	Boraginaceae	
ARAB	Rockcress	*Arabis species*	Perennial Forb	Cruciferaceae	
AREN	Sandwort species	*Arenaria*	Perennial Forb	Caryophyllaceae	
ARSO	Foothills Arnica	*Arnica sororia*	Perennial Forb	Compositae	
ARUN	Goatsbeard	*Aruncus sylvester*	Perennial Forb	Rosaceae	
ASTR	Locoweed sprecies	*Astragalus*	Perennial Forb	Leguminosae	
BAHO	Hooker's Balsamroot	*Balsamorhiza hookeri*	Perennial Forb	Compositae	
BASA	Arrow-leaf Balsamroot	*Balsamorhiza sagittata*	Perennial Forb	Compositae	
BROD	Brodiaea	Brodiaea	Perennial Forb	Liliaceae	
CACH	Desert Paintbrush	*Castilleja chromosa*	Perennial Forb	Scrophulariaceae	
CACQ	Blue Camas	*Camassia quamash*	Perennial Forb	Liliaceae	
CANU	Sego Lilly	*Calochortus nuttallii*	Perennial Forb	Liliaceae	
CAST	Paintbrush Species	*Castilleja*	Perennial Forb	Scrophulariaceae	
CHAE	Chaenactis	Chaenactis	Perennial Forb	Compositae	
CIUT	Utah Thistle	*Cirsium utahense*	Perennial Forb	Compositae	
CREP	Hawksbeard	*Crepis alnifolia*	Perennial Forb	Compositae	
DELP	Delphinium species	*Delphinium*	Perennial Forb	Ranunculaceae	
DEPI	W. Tansy Mustart	*Descurainia pinnata*	Perennial Forb	Cruciferaceae	
DERIO	Dead Buckwheat	*Eriogonum*	Perennial Forb	Polygonaceae	
ERAP	Basin Rayless Daisy	*Erigeron aphanactis*	Perennial Forb	Compositae	
ERCI	Storksbill/Filaree	*Erodium Circutarium*	Perennial Forb	Geraniacea	
ERIG	Daisy species	*Erigeron*	Perennial Forb	Compositae	
ERIO	Buckwheat	*Eriogonum*	Perennial Forb	Polygonaceae	
FRAG	Wild Strawberry	*Fragaria*	Perennial Forb	Rosaceae	L. Barnes
GAAP	Catchweed Bedstraw	*Galium aparine*	Perennial Forb	Rubiaceae	
GAAR	Blanket Flower	*Gaillardia aristata*	Perennial Forb	Compositae	
GABO	N. Bedstraw	*Galium boreale*	Perennial Forb	Rubiaceae	
GETR	Old Man's Beard	Geum triflorum	Perennial Forb	Rosaceae	
GEVI	Sticky Geranium	*Geranium viscosissimum*	Perennial Forb	Geraniaceae	
GRNA	Low Gumweed	*Grindelia nana*	Perennial Forb	Compositae	
HYCA	Dwarf Waterleaf	Hydrophyllum capitatum	Perennial Forb	Hydrophyllaceae	
IRIS	Iris Species	*Iris*	Perennial Forb	Iridaceae	
LEPU	Granite Gilia	Leptodactylon pungens	Perennial Forb	Polemoniaceae	
LIBU	Prairie Star Flower	Lithophragma bulbifera	Perennial Forb	Saxifragaceae	

Appendix D, Continued.

LIPE	Blue Flax	*Linum perenne*	Perennial Forb	Linaceae	
LIRU	Puccoon	*Lithospermum ruderale*	Perennial Forb	Boraginaceae	
LITH	Prairie Star	*Lithophragma (2sp.)*	Perennial Forb	Saxifragaceae	
LOMA	Lomatium Species	*Lomatium*	Perennial Forb	Umbelliferae	
LUPI	Lupine Species	*Lupinus*	Perennial Forb	Leguminosae	
MELO	Bluebells	*Mertensia longiflora*	Perennial Forb	Boraginacea	
MENT	Mint Species	*Mentha*	Perennial Forb	Labitae	
MICR	Microseris species	*Microseris*	Perennial Forb	Compositae	
OECA	Desert Evening Primrose	Oenothera caespitosa	Perennial Forb	Onagraceae	
OPPO	Prickly Pear	*Opuntia polyacantha*	Perennial Forb	Cactaceae	
OXYT	Crazy weed	*Oxytropis*	Perennial Forb	Leguminosae	L. Barnes
PECY	Blue Penstomen	*Penstemon cyaneus*	Perennial Forb	Scrophulariaceae	
PESI	Hedgehog Cactus	*Pediocactus simpsonii*	Perennial Forb	Cactaceae	
PF	Unknown Perrenial Forb		Perennial Forb		
PHAC	Phacellia	Phacellia	Perennial Forb	Hydrophyllaceae	
PHLO	Phlox Species	*Phlox*	Perennial Forb	Polemoniaceae (Phlox)	
POLY	Knotweed	*Polygonum*	Perennial Forb	Polygonaceae	
POTE	Potentilla Species	*Potentilla*	Perennial Forb	Rosaceae	
SAAU	Russia Thistle 2002	*Salsola australis*	Perennial Forb	Amaranthaceae	
SAKA	Russian Thistle 2003	*Salsola kali*	Perennial Forb	Amaranthaceae	
SEIN	Western Groundsel	Senecio integerrimus	Perennial Forb	Compositae	
SPCO	Globe Mallow	*Sphaeralcea coccinea*	Perennial Forb	Hypericaceae	
TAOF	Common Dandelion	*Taraxacum officinale*	Perennial Forb	Compositae	
THIS	Thistle Species		Perennial Forb	Compositae	
TRMA	Large-headed Clover	Trifolium macrocephalum	Perennial Forb	Leguminosae	
TRSP	Clover Species	*Trifolium species*	Perennial Forb	Leguminosae	
VECA	False Hellebore	*Veratrum californicum*	Perennial Forb	Liliaceae	
VICI	Vetch Species	*Vicia*	Perennial Forb	Leguminosae	
VIOL	Violet	Violet species	Perennial Forb	Violaceae	
VITI	Grape	*Vitis*	Perennial Forb	Vitaceae	
WYAM	Mules Ear	Wyethia amplexicaulis	Perennial Forb	Compositae	
WYHE	White-rayed Wyethia	*Wyethia helianthoides*	Perennial Forb	Compositae	
ZYVE	Death Camus (zypa in 2002)	*Zygadenus venenosus*	Perennial Forb	Liliaceae	
AGRO		*Agro*	Perennial Grass	Gramineae	L. Barnes
FEME	Six-week Fescue	*Festuca megalura*	Perennial Grass	Gramineae	
FEOV		*Fescue ovina*	Perennial Grass	Gramineae	L. Barnes
FEOV		*Festuca ovina*	Perennial Grass	Gramineae	L. Barnes
FESC	Fescue	*Festuca*	Perennial Grass	Gramineae	L. Barnes
SITA	Squirreltail Grass	*Sitanion*	Perennial Grass	Gramineae	L. Barnes
STIP	STIPA Genus	*Stipa*	Perennial Grass	Gramineae	L. Barnes
STLE		Stipa lemmonii	Perennial Grass	Gramineae	L. Barnes
STLE		*Stipa lettermani*	Perennial Grass	Gramineae	L. Barnes
ROCK	rock		Rock		
AMEL	Serviceberry	*Amelanchier*	Shrub	Rosaceae	
ARTB	Basin Big Sagebrush	*Artemisia t. tridentata*	Shrub	Compositae	

Appendix D, Continued.

ARTL	Low Sagebrush	*Artemisia arbuscula*	Shrub	Compositae
ARTR	Unidentified Sagebrush	*Artemisia*	Shrub	Compositae
ARTRD	Dead Sagebrush 2003	*Artemisia sp. (dead)*	Shrub	Compositae
ARTT	Three-tipped Sagebrush	*Artemisia tripartita*	Shrub	Compositae
ARTV	Vaseyana Sagebrush	*Artemisia t. vaseyana*	Shrub	Compositae
ARTW	Wyoming Big Sagebrush	*Artemisia t. wyomingensis*	Shrub	Compositae
ATCA	Shadscale	*Atriplex Canescens*	Shrub	Chenopodiaceae
ATCO	Spiny Sage	Atriplex confertifolia	Shrub	Chenopodiaceae
ATSP	Spiny Hopsage	*Atriplex spinosa*	Shrub	Chenapodiaceae
BERE	Oregon Grape	*Berberis*	Shrub	Berberidaceae
CEAN	Ceanothus	*Ceanothus*	Shrub	Rhamnaceae
CELE	Mountain Mahogany	*Cerocarpus ledifolius*	Shrub	Rosaceae
CHNA	Gray Rabbitbrush	*Chrysothamnus nauseosus*	Shrub	Compositae
CHVI	Green Rabbitbrush	*Chrysothamnus viscidiflorus*	Shrub	Compositae
CHVID	Dead Green Rabbitbrush 2003	*Chrysothamnus*	Shrub	Compositae
CRAT	Hawthorn	*Crataegus*	Shrub	Rosaceae
DARTR	Dead Sagebrush 2002	*Artemisia sp. (dead)*	Shrub	Compositae
DCHVI	Dead Green Rabbitbrush 2002	*Chrysothamnus*	Shrub	Compositae
DJUOC	Dead Juniper 2002	*Juniperus occidentalis*	Shrub	Pinaceae
DPUTR	Dead Bitterbrush 2002	*Pursia tridentata*	Shrub	Rosaceae
DS	Dead Shrub		Shrub	
EULA	Winterfat 2003	*Eurotia lanata*	Shrub	Chenopodiaceae
EVLA	Winterfat 2002	*Eurotia lanata*	Shrub	Chenopodiaceae
JUNI	Juniper	Juniperus occidentalis	Shrub	Pinaceae
JUOC	Juniper	Juniperus occidentalis	Shrub	Pinaceae
JUOCD	Dead Juniper 2003	*Juniperus occidentalis*	Shrub	Pinaceae
PIDE	Budsage	*Picrothamnus desertorum*	Shrub	Compositae
PRUN	Cherry Species	*Prunus*	Shrub	Rosaceae
PRVI	Choke Cherry	*Prunus virginianus*	Shrub	Rosaceae
PUTR	Bitterbrush	*Pursia tridentata*	Shrub	Rosaceae
PUTRD	Dead Bitterbrush 2003	*Pursia tridentata*	Shrub	Rosaceae
RIBE	Currant Species	*Ribes*	Shrub	Grossulariaceae
ROSA	Rose Species	*Rosa*	Shrub	Rosaceae
SALI	Willow Species	*Salix*	Shrub	Salicaceae
SAMB	Elderberry	Sambucous	shrub	Rosaceae
SAVE	Greasewood	*Sacrobatus vermiculatus*	Shrub	Chenopodiaceae
SHRUB	Unidentified Shrub		Shrub	
SPDE	Budsage (old taxonomy)	spinescens-desertorum	Shrub	Compositae
SYOR	Mountain Snowberry	*Symphoricarpos oreophilus*	Shrub	Caprifoliaceae
TESP	Spiny Horsebrush	*Tetradymia spinosa*	Shrub	Compositae
UNKN	Unknown		Unknown	
STREAM	moving water		Water	

Appendix E. Summary of Greater Sage-Grouse preferred forb estimations at Craters bird sampling plots.

Plot	Suitability	Sign Observed?	Plot	Suitability	Sign Observed?
A2G	SUITABLE	Yes	C34P	MARGINAL	No
A2M	MARGINAL	Yes	C35G	SUITABLE	No
A2P	UNSUITABLE	Yes	C35M	SUITABLE	No
C11G	SUITABLE	Yes	C35P	SUITABLE	No
C11M	SUITABLE	No	C38G	SUITABLE	No
C11P	MARGINAL	Yes	C38M	SUITABLE	No
C15G	MARGINAL	No	C38P	SUITABLE	No
C15M	MARGINAL	Yes	C39G	MARGINAL	No
C15P	MARGINAL	No	C39M	UNSUITABLE	No
C16G	SUITABLE	Yes	C39P	UNSUITABLE	No
C16M	MARGINAL	Yes	C7G	SUITABLE	No
C16P	SUITABLE	No	C7M	SUITABLE	Yes
C19G	SUITABLE	No	C7P	MARGINAL	No
C19M	MARGINAL	No	L31G	SUITABLE	No
C20G	MARGINAL	No	L31M	MARGINAL	No
C20M	MARGINAL	No	L31P	MARGINAL	No
C20P	SUITABLE	No	L33G	SUITABLE	No
C23G	SUITABLE	Yes	L33M	SUITABLE	No
C23M	MARGINAL	No	L33P	MARGINAL	No
C23P	MARGINAL	No	L41G	SUITABLE	No
C25G	SUITABLE	No	L41M	MARGINAL	No
C25M	SUITABLE	No	L41P	MARGINAL	No
C25P	MARGINAL	No	L42G	SUITABLE	No
C29G	SUITABLE	No	L42M	SUITABLE	No
C29M	SUITABLE	No	L42P	SUITABLE	No
C29P	MARGINAL	Yes	L46G	SUITABLE	No
C30G	SUITABLE	No	L46M	MARGINAL	Yes
C30M	MARGINAL	No	L46P	MARGINAL	No
C30P	MARGINAL	No	L48G	SUITABLE	No
C34G	MARGINAL	No	L48M	SUITABLE	No
C34M	MARGINAL	No	L48P	MARGINAL	No